

Advisory Committee on Acoustic Impacts on Marine Mammals

Sponsored by the Marine Mammal Commission

**Second Meeting
April 28-30, 2004**

Arlington, Virginia

Final Meeting Summary

August 10, 2004

Prepared by the Facilitation Team of

**Suzanne Orenstein
Lee Langstaff
Linda Manning
Regan Maund**

Advisory Committee on Acoustic Impacts on Marine Mammals

Second Plenary Meeting
April 28-30, 2004
Crystal City Sheraton – Arlington, VA

Final Meeting Summary

The second meeting of the Advisory Committee on Acoustic Impacts on Marine Mammals was held on April 28-30, 2004 in Arlington, Virginia. The Advisory Committee, convened by the Marine Mammal Commission, is comprised of a diverse group of representatives of entities that produce sound in the marine environment, government agencies with responsibilities or activities significant to marine mammals, academic researchers, and non-governmental environmental and animal welfare organizations (The list of meeting participants can be found as Attachment 1). The objectives of this meeting were:

- To discuss tools available and/or needed to best determine the levels of noise that represent a risk to marine mammals;
- To discuss the development and application of NOAA Fisheries' proposed Noise Exposure Criteria for evaluating the risk to marine mammals from anthropogenic noise; and
- To develop an information base for discussing mitigation questions at future meetings.

What follows is a summary of the presentations and discussions at this meeting.

DAY ONE – Wednesday, April 28, 2004

Welcome and Introductions

David Cottingham, Executive Director of the Marine Mammal Commission, opened the meeting by welcoming the Committee members. He also introduced the representatives from Minerals Management Service and the Scripps Institution of Oceanography who were participating in their first meeting of the Advisory Committee.

Mr. Cottingham made several announcements regarding the work of the Advisory Committee:

- The Subcommittee on Synthesis of Current Knowledge has worked diligently since the last meeting. They held a preliminary conference call and a subsequent meeting in Rhode Island, and will report on their progress later in the meeting. They will meet briefly after the end of this meeting and their next meeting will be held during the first week of June.
- There will be a report later in the day outlining the highlights of the Beaked Whale Technical Workshop that the Commission held in Baltimore on April 14-16. This workshop was well attended by a wide variety of participants and was quite successful.
- The Marine Mammal Commission approached the United Kingdom's Joint Nature Conservation Committee (JNCC) about forming a partnership to sponsor the international policy workshop scheduled for the last week in September in London. JNCC agreed to cosponsor the meeting and is engaged in planning with the Commission.
- Advisory Committee staff request assistance from Committee members in two areas:

1. Committee members should follow guidelines on government travel rates if the Commission is reimbursing their travel expenses. Please let the Commission staff know if you encounter problems meeting this requirement.
 2. The Advisory Committee will make more progress if Committee members keep open minds and actively listen to the information and proposals being discussed. This takes much patience but it is needed in order for us to find common ground.
- The next meeting of the Advisory Committee will be held July 27-29 in San Francisco.
 - Members of the California Congressional delegation submitted a letter of public comment regarding the Advisory Committee's work. The Marine Mammal Commission responded to this letter, but there will be a discussion later in the meeting to determine if the Advisory Committee would like to respond further.

Mr. Cottingham expressed his appreciation for the work of Committee members on the meeting summary for the first Advisory Committee meeting, and for their attendance and engagement at this meeting.

Suzanne Orenstein, Lead Facilitator, requested that Committee members, Committee staff, observers, and facilitators introduce themselves to the group.

Agenda for this Meeting

Suzanne Orenstein briefly reviewed the agenda for the meeting. Several members made comments and suggestions about the agenda:

- The discussion of the management and mitigation subcommittee is important. We need to move forward on this effort and make sure that there is time for this discussion.
- When we discuss the letter from the California Congressional delegation, their staff would like to be present. Can we set a specific time for the discussion? (The discussion was scheduled for Friday morning.)
- It would work best for the chair of the Beaked Whale Workshop to provide his report earlier than scheduled. A proposal was made to switch the public comment session and the workshop report on the first day's agenda, and all agreed.

Ms. Orenstein then reminded Committee members and the public about the meeting protocols and the procedures for the public comment period.

Discussion of Operating Procedures

The Committee discussed its Operating Procedures on both the first and last day of the Advisory Committee meeting. Both discussions are summarized here. A copy of the Operating Procedures, as revised in the meeting, is included as Attachment 2.

Purpose and Goal: A proposal to expand the language describing the purpose of the Advisory Committee was presented by the Commission in response to comments made at the previous meeting. After discussion about the proposal, the Committee agreed to make no change to the language in the Operating Procedures.

Technical Resources: The Committee then discussed a proposal for revised language regarding technical resources for the Committee. The issue of discussion was the role of the Committee in

recommending technical experts for the Commission to engage. Some members expressed discomfort that, based on the consensus ground rule, proposed experts could be vetoed by a single member, and noted that this situation has already arisen in the Subcommittee on Synthesis of Current Knowledge. After another member noted that multiple experts had been proposed in the subcommittee situation, a proposed solution was suggested to allow technical experts on all sides of an issue to participate when no consensus can be reached on a single expert in order to avoid concerns over vetoes and one-sided information. Ms. Orenstein offered to draft new language based on the Committee's desire for consensus on the process to engage technical experts. The proposed new language was adopted and appears in the revised Operating Procedures in Attachment 2.

Subcommittee Rules of Operation: The discussion on technical experts led to a more general examination of whether or not the subcommittees should be held to the same consensus requirements as the Advisory Committee. The Committee concluded that the subcommittees should use the same consensus rule as that followed by the larger Committee, and language was added to make this requirement explicit in the Operating Procedures.

Alternates: A member asked whether it is possible to allow representation (e.g., a second alternate) beyond the Committee member and his or her designated alternate if neither person can be present at a meeting. The Committee decided that, in specific cases such an exception could be made, but that advance notice to Committee members must be given and that this should not become a regular occurrence. Several members voiced the concern that it is essential that the same individuals represent their groups on a consistent basis so that the important work of the Committee can be completed in an efficient manner. The Committee agreed not to amend the Operating Procedures to address this clarification.

Safeguards (Section 5): The Committee addressed several provisions in this section. The *good faith* definition requiring consistency of one's expressed views in multiple fora and openness to new ideas was accepted. The Committee adopted a new subsection on Committee products stating that all *preliminary agreements are provisional* until agreement on the entire Committee report is reached. Questions arose as to whether there would be a *minority report* accompanying the Advisory Committee's report. The Operating Procedures state that disagreements will be outlined in the final report, and the Committee agreed not to amend the Operating Procedures to address this clarification. Another question was raised concerning *the content of the Commission report* to Congress and whether the Committee would have a chance to review it. Mr. Cottingham expressed his hope that the Advisory Committee's report would provide most, if not all, of the content of the Commission's report to Congress. Concerns were still expressed about the administrative review process for the Commission's report and in response Mr. Cottingham agreed to send the Commission's draft report to Committee members for review and comment via electronic mail. Mr. Cottingham also reiterated the Commission's plan to transmit verbatim the Advisory Committee's report to Congress.

The Committee discussed whether *contacts between Committee members and Congressional representatives* were consistent with good faith provisions of the Operating Procedures. Some felt such contacts were not consistent, and emphasized the need for Committee members to agree not to go outside of the Committee process (to Congress or others) for the purpose of generating undue pressure or influence on the Committee. Rather, Committee members should raise concerns themselves directly with the Committee. Others noted that it would be inappropriate to ask Committee members to give up their normal activities and interactions with Congress or others outside the Committee. Ms.

Orenstein reminded the members that the good faith provisions ask that members act consistently in various fora, and the Operating Procedures further make it a responsibility of members to raise concerns about the Committee process within the group before going outside the Committee to advocate for changes. Finally, Jessica Maher, staff with Representative Sam Farr, the primary author of the letter, stated that the public comment letter from members of the California Congressional delegation, which was the catalyst for this discussion, was written in response to observations made by congressional staffers who were present at the initial Committee meeting and not at the request or suggestion of a Committee member or members. No changes were made to the Operating Procedures as a result of this discussion.

Meeting Procedures (Section 6): In extensive discussion over two days of the meeting, several proposals to amend the Operating Procedures regarding the meeting procedures were debated. A proposal to name a chair for the Committee was discussed, but not accepted. Proponents of this proposal expressed the desire to have someone help the Committee move to closure and progress more quickly. Others held the view that a chair could polarize the Committee, unless he or she was not a member. The Committee did not reach consensus, and everyone agreed to live without a chair. In a related discussion, draft language specifying the option for a Process Steering Subcommittee was not accepted. Some members felt that another Subcommittee was not an expeditious route for the Committee to follow. Mr. Cottingham noted that the Commission and facilitators are always open to receiving process suggestions and input from Committee members. When a member suggested that some portions of the Advisory Committee meetings be conducted in a closed session, the Committee briefly discussed the proposal and did not adopt the suggestion.

Facilitation: One member proposed adding language to the facilitation provision stating that the purpose of the facilitation was to create a safe and balanced forum in which each Committee member could interact, freely debate, and disagree without obvious concern for negative consequences. Language was drafted and adopted.

Meeting Summaries: Several members endorsed a proposal to tape and transcribe the plenary meetings of the Advisory Committee. Other members noted that the meeting summary produced for the first meeting was a thorough and accurate reflection of the proceedings and was helpful to inform those who did not attend. Advocates for taping and transcribing meetings suggested that it would be very helpful to have an exact record of all that was said at these meetings so that those involved could return to the specific wording of Committee member comments. Some members noted that creating tapes and transcripts was an expensive undertaking with little practical benefit. Other members noted their concern that the tapes would be used outside of the process to put specific members at a disadvantage, and the fear of that use might make members overly cautious in Committee discussions. The debate about taping involved strong feelings on all sides, and was eventually resolved on issues of practicality. On the last day of the meeting, the Committee agreed that any member who would like a tape of the meeting could arrange with the Commission to use the provided sound system and produce their own tape. The Committee further agreed to an electronic review of the draft meeting summary within ten business days of its distribution by the facilitators, so that the draft summary can be posted on the web site before the next plenary Committee meeting.

Presentations

The Committee devoted a significant portion of the first two days of this meeting to presentations about issues involved in assessing risk to marine mammals from sound. Highlights of each

presentation are summarized below. All presentation slides can be viewed on the Commission web site at www.mmc.gov/sound/plenary2.

Background on Assessing the Risk to Marine Mammals from Anthropogenic Sound –

Presentation by Douglas Wartzok, Vice Provost and Dean, Florida International University and Member of the Committee of Scientific Advisors to the Marine Mammal Commission

Dr. Wartzok reviewed the approaches and findings of four recent National Research Council (NRC) panels and the High Energy Seismic Survey (HESS) Committee process, including the different approaches to risk assessment exemplified by each. The NRC panels relied primarily on published material to frame issues and identify gaps in current knowledge. The resulting reports were externally peer-reviewed and widely circulated. The HESS process used an “Expert Opinion” format in which a group of experts was brought together and tasked with reaching consensus on the bounds of a given problem. This approach did not use an external peer review process, and produced meeting transcripts rather than reports.

The goal of the HESS process, which was convened by the Minerals Management Service (MMS), was to reach consensus on the application review process and develop a set of mitigation measures for high-energy seismic studies proposed in California state waters and federal waters within the study area. At their 1997 meeting the selected experts specifically addressed safety zones and zones of potential harassment, transmission loss models, ramp-up, monitoring, and priority species for protection on the California coast. The results of the HESS process produced criteria used by regulators to begin to determine marine mammal risk from acoustic activities. Up until that time, NOAA Fisheries had been using interim criteria based on data from terrestrial mammals. The new criteria were 180 dB (all values in this section are rms re 1 μ Pa) for injury and 160 dB for potential harassment. In 1998 the HESS Expert Group was reconvened by NOAA Fisheries with some additional participants to address additional questions and issues that arose from their prior findings and recommendations. The group was asked to review the 180 dB criterion and decide if a different threshold was acceptable for pinnipeds and odontocetes, other than sperm whales. The group recommended raising the threshold to 190 dB for pinnipeds. It was also noted that the HESS criterion applied specifically to sounds generated by seismic surveys, not other activities.

In 1994, the NRC established a committee to consider issues surrounding low frequency sound and marine mammals. The committee was created to evaluate the Acoustic Thermometry of Ocean Climate (ATOC) proposal to use high source level, low-frequency sound traveling on long-distance undersea paths to determine temperature change in the ocean resulting from global climate change. The main charge to the NRC panel was to review current knowledge and on-going research on the effects of low frequency sound on marine mammals. The panel concluded that current data were insufficient to predict the effects of intense, low frequency sound on any marine species, and that sounds below 100 Hz were unlikely to be in a sensitive range for odontocetes and most pinnipeds. The panel also recommended possible statute and regulatory changes regarding the definition of harassment and the permitting process.

In 2000, the NRC convened another panel to review the results of ATOC’s marine mammal research program, as well as to review other relevant research and identify gaps. Dr. Wartzok summarized the panel’s findings as follows.

The 2000 NRC panel concluded that 1) the research program was unable to demonstrate the absence of significant effects of ATOC emissions on marine mammals, 2) not detecting reactions is

not sufficient evidence that there is no significant impact, and 3) while there is no cause for alarm with respect to short term effects of ATOC on dolphins and most seals, there is cause for concern because short term and long term effects of ATOC, especially on baleen whales and sperm whales, cannot be ruled out. They went on to recommend that a regulatory threshold for Level A harassment be related to the likelihood of causing temporary threshold shift (TTS) and the magnitude of that TTS, and suggested that a sound causing a 10 dB or less TTS separated by non-exposure intervals of 24 hours for recovery would fall below the Level A threshold. This panel also recommended a change in the definition of Level B harassment to include the meaningful disruption of biologically significant activities.

The NRC panel convened in 2003 was asked to evaluate all identifiable sources of human and natural sound contributing to ambient sound levels, and to evaluate the overall impact of man-made sound on the marine environment. The panel concluded that although the overall impact is unknown, there is cause for concern. This panel also recommended a focus on impacts on marine life that have population-level consequences, and made several recommendations for improving the information base for regulatory decisions (e.g. a common database of all known anthropogenic sound sources to be used in the development of a global ocean noise budget). Another NRC panel was convened in 2004, responding to the 2000 NRC panel's recommendations to address the definition of a biologically significant response to noise. The panel has not published its report yet, but it is considering a conceptual approach that examines the links from acoustic stimuli, to behavioral responses, to functional outcomes of responses (integrated over daily and seasonal cycles), to life history models and population-level responses.

In sum, Dr. Wartzok noted that these two approaches to marine mammal risk assessment – expert opinion, and review and synthesis of peer-reviewed literature – have developed similar findings on questions dealing with the risk to marine mammals from anthropogenic sound. Dr. Wartzok noted that both approaches found that there is a lack of essential data; that a precautionary approach should be taken in the absence of data; that the absence of evidence does not translate into absence of effect; that a common metric should be developed for all effects of human activities on marine mammals, with PBR suggested in several reports as this metric; and that regulatory activities should be directed toward those activities with the most significant effects on populations.

Comment: A member of the HESS panel who is on the Advisory Committee noted that the HESS safety zones and 180 dB criterion were developed to address physiological injury, not behavioral impacts.

Question: Did the NRC seek international input as they were developing international recommendations that they then sent to the U.S. government? Was International Council for the Exploration of the Sea (ICES) information involved?

Response: Yes, there was some international representation on the panel. There was a continual flow of information between U.S. and international experts, but the policy recommendations focused on the U.S.

Question: Did the committee look at non-cetaceans? Did they look at effects above the water (i.e., on the surface or on land)?

Response: The 2003 committee did cover the range of species and included some information on effects of aircraft noise. The 1994 and 2000 reports focused on underwater, low-frequency sound and low frequency sound does not propagate well into very shallow waters. The focus was primarily on the marine environment in areas where the potential for effects was strongest.

Question: These committees focused primarily on auditory impacts rather than other physiological impacts. Is the NRC planning to look at a broader range of impacts?

Response: There was nothing published on non-auditory physiological impacts in the peer-reviewed literature at the time, so these impacts were not considered by NRC. But NRC recommended doing research on the full range of impacts. We don't know whether the NRC is planning to look at non-auditory physiological impacts now or in the future.

Current Risk Assessment Activities under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA)

ESA Risk Assessment Framework – *Presentation by Penny Ruvelas, Section 7 Coordinator, Southwest Region, NOAA Fisheries*

Ms. Ruvelas presented the risk assessment framework applied by NOAA Fisheries when determining whether an activity is likely to jeopardize a threatened or endangered species. The key question in this approach is whether a proposed action is likely to jeopardize the continued existence of a listed species, and the general method is to break down the activity into its components and understand the impact of each component on the target species. She described the analytical model followed by NOAA Fisheries with particular emphasis on 1) the exposure analyses, 2) the response analyses, and 3) the risk analyses that should be conducted. In brief, the goal of the exposure analysis is to determine whether the species will experience the “stressors” or component effects of the activity. This is done by creating an exposure profile to examine whether or not the species will co-occur with the stressors over space and time. The goal of the response analysis is to determine the dose-response of species’ reactions upon exposure. These responses generally fall along a continuum of increasing severity, from no response to lethal response (death). Finally, the goal of the risk analysis is to determine whether the combination of exposure and response is sufficient to affect the species’ ability to survive and reproduce, or their overall probability of extinction. These elements are considered from both an individual viewpoint as well as from a demographic or population perspective.

Negligible Impact Determination – *Presentation by Donna Wieting, Deputy Director, Office of Protected Resources, NOAA Fisheries*

Ms. Wieting presented the process followed by the NOAA Fisheries Incidental Take Authorization Program for determining what constitutes negligible impact under Section 101 (a)(5)(A and D) of the Marine Mammal Protection Act (MMPA). The negligible impact determination is based on 1) whether there will be a “taking” of an individual marine mammal, and 2) whether the takings will affect the reproduction and survival of the species or stock. This process is rooted in the MMPA harassment definition and regulatory language.

Negligible impact is defined in the Code of Federal Regulations as an impact resulting from a specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival. Ms. Wieting described the information required to perform an analysis for a negligible impact determination and provided examples of when takings may not be authorized or may be very limited. For example, these determinations may rely first on Potential Biological Removal (PBR) levels. If a PBR level has been set at zero or a low number for a stock, then taking by serious injury or mortality would likely not be authorized, whereas higher PBR levels might suggest takings could be allowed. Risk analysis

also considers the type of taking (e.g., behavioral harassment or potential non-serious injury) and duration of activity in addition to PBR. The risk assessment procedure looks at risk in the absence of implementation of mitigation or monitoring measures, but the incidental take authorizations issued almost always include mitigation measures to avoid injury or mortality. For longer-term activities, cumulative impacts are considered and National Environmental Policy Act (NEPA) analyses are required. Ms. Wieting presented an example of the application process and risk assessment procedure that occurred for the USS Winston S. Churchill ship-shock trial. Reviews were conducted under NEPA, MMPA, and ESA, and extensive mitigation and monitoring were required before and during detonation. Post-detonation monitoring revealed no mortalities.

Ms. Wieting noted that each application and authorization for incidental take provides information (especially on mitigation measures) that helps to improve the review, determination, and mitigation processes. This process requires a great deal of information from applicants to ensure that the risk assessment is as well informed as it can be.

Question: It would be hard to make these types of decisions without information on specific time, place, and species – correct? Therefore, generalizations cannot be made about risk.

Response: Yes, though we have made decisions with less information. The key is to recognize uncertainty and temper the process by looking at similar cases in the past, and to explain how the uncertainty was dealt with. In the ESA process, there is an acknowledgement and assessment of the extent of uncertainty, and then use of assumptions, expert opinion, and appropriate surrogates to make decisions.

Question: EPA recently came out with guidance for risk assessors on their staff. This guidance focused on probabilistic risk assessment coupled with uncertainty analyses. Do you consider their risk assessment guidelines in any way?

Response: Yes, we use EPA risk assessment guidelines as guidance. We also differ from EPA in that we have specific statutory language regarding the use of the best available information, a topic on which there is vigorous internal debate. If sufficient data were available we would apply those probabilistic types of tools, but most often this is not possible.

Question: The models are only as good as the data input. There are lots of questions when dealing with marine issues, especially with marine mammals. How do you deal with uncertainty in critically important areas? On the question of how sound affects whales, the amount of data available is very scarce and most disagreements arise from how uncertainty is handled and how regulatory decisions are made based on imperfect information.

Response: The gaps in the data are precisely why we don't have the models to work with that we would like, but we have a great deal of past experience to temper uncertainty and make decisions that are consistent. We would like to have Advisory Committee input on how to improve how we deal with uncertainty.

Question: Is critical habitat under the ESA considered in NOAA Fisheries risk assessments? Where does that fit in?

Response: Critical habitat is a crucial element of the analysis – it can be up to fifty percent of the risk assessment. Due to the time constraint of this presentation, we focused primarily on the jeopardy standard and exposure elements of the risk analysis.

Question: On the negligible impact decisions, how do fishery takes (i.e., bycatch) affect the MMPA determinations?

Response: We have to consider the full range of takes including those from the fisheries when doing PBR calculations. PBR is a concept used in commercial fisheries management that takes the “global” scope of takes into account in order to inform the determination of the allowable take for a given fishery. It is a reflection of the sum of all of the human impacts. However, there is a statutory difference in how fisheries takes are handled compared to other kinds of takes.

Question: If fishery takes create a low PBR number, does the next activity that applies for a take get automatically denied?

Response: The authorization process doesn’t look at the situation in such a sequential manner. PBR is not an allocation scheme used as cut-off point, but as a way to look at the full picture of human impacts.

Comment: One member suggested that the Committee’s report should at least provide, perhaps in its introduction, context regarding impacts of anthropogenic sound on animals relative to other known human-made impacts, such as fishing bycatch. Other members noted that providing such context would be difficult given the lack of knowledge of the biological impacts of ocean noise and that other types of impacts on marine mammals, such as bycatch, are already being considered through other processes.

Question: How are unpublished data used and incorporated?

Response: We look at the best available data, and that includes both unpublished and non-peer reviewed information. For instance, we may use an as-yet-unpublished draft stock assessment report. We prefer to use the best available information provided in the peer-reviewed literature, but we also have a responsibility to use the best available information wherever it may be found.

Comment: For a resource manager, the risk assessment process is important and highlights the information and data gaps. Applicants are generally not the best people to find the key data. We need adequate funding for resource management agencies to fill the data gaps.

Question: There seem to be regulated and unregulated activities. Unregulated activities, like recreational fishing and commercial shipping, do not appear to come under the purview of the NOAA Fisheries permit process. We have required mitigation of such activities for ESA purposes on land (e.g., protective measures for piping plovers), but how are these activities covered when doing risk assessments for marine species? Could an ecosystem- or habitat-based model be applied?

Response: Section 10 of the Endangered Species Act could cover some of these unregulated activities and the MMPA does cover some of these non-permitted activities, because we have the ability to regulate any activity that results in harassment or injury. For example, we are beginning to work on regulations governing small watercraft. For ESA reviews, NOAA Fisheries also considers unregulated activities when evaluating the status of the species and their environmental baseline. All of these actions are considered when assessing the baseline risk of probability of quasi-extinction in order to then determine if the proposed federal action would increase that probability.

Mitigating the Risks to Marine Mammals from Acoustic Operations – Presentation by John Harwood, NERC Sea Mammal Research Unit, Centre for Research into Ecological and Environmental Modeling, University of St. Andrews

Dr. Harwood described his work applying the EPA approach for environmental risk mitigation to marine mammal and sound issues. This framework includes hazard identification, exposure assessment and exposure-response assessment, risk characterization, and risk management. Risk

was defined as the probability that something undesirable will happen. Quantitative risk assessments are about quantifying the probabilities, and therefore helping decision makers determine what level of risk is acceptable.

Dr. Harwood noted the numerous physiological and behavioral consequences associated with marine mammal exposure to hazards presented by acoustic operations. He then explained that the exposure assessment is a critical step that depends on a combination of the emissions from the acoustic source and their attenuation, and the distribution and behavior of all marine mammal species in three dimensions. He outlined what is known about global marine mammal distribution and how this information is gathered. Sources of marine mammal data include dedicated research surveys, opportunistic surveys, strandings, and telemetry (tagging). These sources provide patchy coverage at best, when considered from a global perspective. Interpolation and extrapolation techniques can be used to estimate distribution and learn about behavior in areas where there is a paucity of data. Overall, however, finer detail about behavior and other parameters is desirable.

With this type of data, and using interpolation and extrapolation techniques, it is possible to look at the probability of overlap between marine mammal populations and acoustic impacts in order to determine potential exposure. To understand the risk, however, the exposure response of each species needs to be determined. Little work has been done in this area on marine mammals, though some terrestrial species are relatively well studied. Identifying a threshold response has been the focus, but this measure, while useful for physiological effects, is not very useful when considering behavioral effects.

Once threshold exposure values are established, a hazard exposure estimate or “probability surface” can be developed to characterize the risk for each species in the area where acoustic operations are planned. However, use of mean data values to develop this surface results in the threshold being exceeded half of the time, so it is important to find ways to account for uncertainty and temper the data. Dr. Harwood identified the key sources of uncertainty that need to be accounted for in developing a probability and risk characterization. They include: process stochasticity, observation error, implementation error, model error, and ignorance. He noted that all but one – ignorance – are measurable. This type of characterization can provide an approach that is essentially a quantitative version of a standard environmental impact assessment.

It is important to recognize that the risk mitigation strategy adopted through any risk assessment process is also likely to be based on data with high levels of uncertainty. We know, and our risk assessment models must acknowledge, that what we know is a tiny fraction of what we would need to know to inform robust risk assessment and effective risk reduction. Most of the analytical techniques we need are available now, but the data remains the significant limiting factor. Actual events may be quite different from what we would predict, and real data are needed to improve the process. As new data become available and uncertainty declines there must be mechanisms for updating the risk assessment.

Dr. Harwood noted that he had used additional slides beyond those that were distributed to the Committee. The full set of slides will be posted on the web site at www.mmc.gov/sound/plenary2.

Comment: Several Committee members commented on the need to include in risk assessments a statement of what the assessment can and cannot tell policy makers. Members noted that there should be a clear articulation of what the uncertainties and assumptions are.

Response: Yes, this is often not done but could be. The approach presented here allows the explicit accounting of all known uncertainties, identifying and evaluating each source of uncertainty. This approach also allows one to see how sensitive the collected information is to uncertainty. Further, a cost-benefit analysis can be developed using this method. Stating assumptions is key. The analysis itself is not complex. It can be tailored to the information that is available. If there is no data you are at the mercy of your assumptions.

Question: Have you used this approach to examine multiple risks concurrently?

Response: We can attach a utility function to each of the outcomes of the model in an effort to weight them in the calculation. The tricky part is finding agreement about the relative importance of each outcome. We have used stakeholder discussions to help establish those weighting functions.

Comments:

- It may be more desirable to set a threshold so that these complicated risk assessment procedures are not applied unnecessarily to every question or issue.
- Bayesian analysis has a lot to offer in accounting for uncertainty, but the choice of dose-response mechanism and exposure-behavioral response is key. The higher the uncertainty, the wider variety of outcomes are possible, but if the mechanisms are wrong (i.e., exposure response) the conclusions reached would not necessarily be precautionary and reflective of this uncertainty.
- These models are very complex and always seem to translate into more data collection. It may be better to side-step risk (i.e., by avoiding shallow water where seals aggregate). It is important to prioritize data needs and identify the areas of models that are most sensitive to uncertainty.
- At the first meeting we heard a definition of the precautionary principle from the Rio Declaration. There are multiple definitions for this principle. Here we've been using a definition that means making choices that provide a cushion to avoid severely negative impacts. There are numerous legal definitions. Should we use one of these? Some of the definitions include cost-benefit analysis. This will be difficult to tackle as a group, but we will need to tackle the definition eventually.

ESME: Effects of Sound on the Marine Environment – *Presented by Robert Gisiner, Marine Mammal Science and Technology, Office of Naval Research*

Dr. Gisiner presented an overview of the Effects of Sound on the Marine Environment (ESME) acoustic risk-modeling program developed by a team of experts convened by the Office of Naval Research (ONR). ESME is a computer program that uses a specified human sound exposure regime to model the risk to protected marine life from acoustic sources. The challenges of modeling acoustic risk to marine mammals include dealing with a complicated four-dimensional problem (in three dimensions in space, plus the temporal dimension), dealing with each step in the sound exposure process (sound source, transmission, receiver, response, and finally, risk), and adjusting assumptions appropriately. The Office of Naval Research initiated the ESME program in 2000 in an effort to integrate many different existing models that dealt with various dimensions of predicting risk (e.g. takings by harassment under the Marine Mammal Protection Act) from acoustic activities.

The goals of the ESME program include using the best available science, capturing uncertainty, developing an integrated model (with multiple data sources and types), providing meaningful

measures of risk, and developing a model that can be easily updated. Examples of the types of data needed include cruise survey or other data on marine mammal location and abundance, which can be incorporated into ESME to identify areas of overlap between acoustic effects and marine mammals; diving profiles of species used to simulate random movement of the target species in three dimensional space; and information about dynamic oceanographic features used to capture environmental variation and the resulting effects on sound transmission. In some cases where no data are available to provide the basis for simulations, Monte Carlo analysis techniques can be used.

Dr. Gisiner described some of the challenges that have arisen in the development of the ESME model. One is the need for guidance on how to appropriately apply the model. Another is the need for exposure limits or criteria based on sound pressure level. Finally, there is a suite of technical problems related to designing and choosing the appropriate components of the model at each step from sound source to receiver response and overall level of risk.

Dr. Gisiner then addressed the question of how the accumulated sound exposure for marine mammals could be estimated. In the ESME model, modeled dive behavior and directional travel, distribution data, and other factors are used to simulate movement patterns and then estimate the cumulative impacts of sound exposure as an animal moves through space and time.

Once the ESME model produces a risk estimate, this level of risk exposure must be correlated with the harassment continuum, which ranges from benign disturbances to fatal injuries. Criteria and thresholds for these exposure levels must be developed, and this development relies on the availability of good data. When data are available, the ESME model applies weighting functions, mostly developed through research on human exposure to acoustic sources, to determine whether an exposure level would constitute harassment.

The challenges that lie ahead for the ESME project include identifying, developing, and maintaining both biological databases and physical databases for acoustic transmission loss modeling. Uncertainty is a major obstacle to risk modeling, especially regarding marine mammal response. The relevant risk metrics for the model to evaluate must be developed by scientists, and selected by policy makers.

In conclusion, Dr. Gisiner noted that 1) with respect to databases, those for acoustic transmission are well developed and readily accessible while biological databases are incomplete, scattered and hard to access; 2) uncertainty or variance in biological data is a major obstacle to planning for risk mitigation; and 3) it is important to remember that quantitative models do not tell us what level of risk is acceptable, they only tell you what the risk is. People, e.g., society and policy makers, are the ones who must determine what impacts are acceptable and how to balance them with other impacts.

Question: How does ESME incorporate cumulative impacts?

Response: We can run long time series (up to one week), but would have to rerun and reiterate these series to model cumulative effects (run the model additively). We could also include multiple sound emitters concurrently (run the model interactively). With different techniques we could eventually model cumulative impacts.

Question: Would it be beneficial to get an “acoustic road map” of geo-referenced sound sources to incorporate into the model?

Response: Ambient acoustics are different from point sources of sound, but both are important and they could be incorporated. It would be useful to compare point sources relative to ambient sound levels.

Question: Is explicit articulation of uncertainties a good idea?

Response: Yes, this is very important. Statistically, uncertainty is cumulative – different parts of the model that have uncertainty associated with them would add together, but utility weighting could be used to deal with this issue. The model tracks sources of uncertainty throughout the different component parts.

Question: In weighting the risks, do you only consider acoustic issues?

Response: ESME is just a sound model (i.e., there are no climate effects or predator/prey interactions incorporated), but these additional elements could be added to the model if desired. There are contaminant models that incorporate these types of elements, but each of these systems has different physics at play. When the physics of different processes are combined (i.e., sound, pollution, harmful algal blooms), the complexity increases.

Acoustic Environment Risk Management for Marine Mammals – Presented by Claire Burt, Naval Systems Department, Defense Science and Technology Laboratories

Ms. Burt presented the approach to marine environmental impact assessment and risk mitigation procedures used by the Royal Navy (RN) in the United Kingdom (U.K.). The overall goal of this approach is to achieve and maintain operational effectiveness with due regard for environmental legislation by taking any necessary measures to protect the environment. The RN must deal with a wide variety of sonar array equipment and technology. Environmental impact assessments (EIAs) are undertaken during active sonar development and acceptance trials as well as new training and exercises. The scope of the EIAs includes acoustic impact criteria, mitigation actions, effect on operations, and future development. The Royal Navy's general approach to the use of active sonar is "Plan, Look, Listen, Act." All activities are derived using the precautionary principle.

Within the UK RN, environmental policy requirements cascade from the top down, with directives related to compliance with environmental law coming from the Secretary of State and Ministry of Defence, implementation happening at the fleet level, and final decisions lying with the commanding officer for a specific case. As a responsible user of the environment who must also defend the U.K., the Royal Navy must balance the procurement of new technology with protecting the environment. Therefore, prior to trials for new equipment or training, the test area is assessed and mitigation actions are developed using the command guidance. In addition, monitoring is put into place before, during, and after the trial. Mitigation measures include avoidance of sensitive areas and habitats for marine mammals (based on temporary and permanent threshold shift criteria), protection of humans, visual and passive acoustic monitoring for marine mammals from both the source ship and in some cases an independent monitoring platform, avoidance of fish spawning areas and visible fish species, and modification of sonar trials in response to environmental monitoring (e.g. cessation or relocation of sonar transmissions). Buffer zone maps are developed based on acoustic impact criteria including human diver aversion, permanent threshold shift (PTS), and temporary threshold shift (TTS). These maps may also include zones of exclusion, which are determined by known marine mammal habitats, and monitoring zones, which are placed around sonar operating platforms to signify the area where monitoring for marine mammals will occur. The buffer and monitoring zones are determined through calculation of the stand-off range, which is

defined as the distance at which sound pressure levels fall within prescribed safe limits (i.e. acoustic impact criteria).

Ms. Burt presented a few examples of this approach and outlined the lessons learned in the course of the EIA work at multiple levels. Among the lessons learned were several addressing coordination and communication of the requirements and protections within the Royal Navy and with external organizations. The resulting strategy is to inform everyone involved, being as open and transparent as possible to enable a good review process by other agencies and independent assessments from non-governmental organizations and other stakeholder groups, as well as cooperation with agencies in the United States, etc.

Question: Are the exclusion zones you mentioned in U.K. marine mammal sanctuaries? What species are covered?

Response: The exclusion zones are based on U.K. candidate Special Areas of Conservation for marine mammals and are set out in the Command Guidance, which you can obtain from Dstl.

Response from Committee Member: The only Special Areas of Conservation in U.K. waters are delineated under the European Union Habitats Directive, and are only for bottlenose dolphins. There are two of these.

Question: Are sea-trial environmental impact assessments available?

Response: They are available to the public, unless the information is classified.

Comment: The reliance on TTS and PTS criteria of generally 160 dB and 180 dB may not be supported by science. We have very little or no data on these levels or their impacts, and what data we do have are uncertain. This is problematic especially when you consider that the stranding events correlated with sonar seem to have involved lower levels of exposure.

Response: We need some guidelines, even if they are imperfect. We use the best information we have, which currently is to assume PTS happens at 180 dB, TTS happens at 160 dB, and human diver aversion happens at 140 dB.

Question: Less than twenty species of cetaceans are found in U.K. waters. The Northwest Approaches and Bay of Biscay are very important beaked whale habitat-- will the Ministry of Defense be looking at ways it can better mitigate test impacts on beaked whales based on the results of the recent beaked whale workshop?

Response: Yes, if the information is made available to us. We deliberately avoid marine mammal "hot spots."

Question: How are the human diver aversion criteria derived?

Response: The naval physiological unit derives them in cooperation with the U.S.

Comments:

- In beaked whales and some porpoises, mortality responses are believed by some, on the basis of sound exposure models and sighting data, to have occurred in the 140-160 dB range. If true, this probably means that the mechanisms of impact are not what we thought they were. If we have an error in the mechanism of the models we use, then the model outputs and mitigation strategies are largely irrelevant, and other mechanisms should be considered.
- The Royal Navy and the U.S. Navy both want to avoid beaked whale habitat areas.
- We don't know where beaked whales are (detection rates are very low), so we cannot avoid them. It is problematic to assume we know where animals are. We should also consider species

other than beaked whales, because there is no reason to believe they are the only animals affected. Other deep diving whales could also be affected. An avoidance approach should be applied not only to beaked whales, but to all marine mammals.

Transparent Reasoning About Measured Risks: The USN LFA Sonar EIS – *Presented by Kurt Fristrup, Bioacoustics Research Program, Cornell Lab of Ornithology*

Dr. Fristrup discussed the risk assessment approach used in preparing the United States Navy (USN) Low-Frequency Active (LFA) Sonar environmental impact statement (EIS). He outlined a two-part process for parsing complex problems and isolating sources of uncertainty. First, complex problems should be broken down so that they are more amenable to discussion and solution. This is the theoretical side of the problem, in which predictive mathematical modeling can be used to estimate the sound exposure level received by marine mammals. Second, simpler questions can be answered with controlled exposure measurements and other methods. This is the empirical side of the problem, in which data gaps are filled with directed research in order to bound the risks from a single exposure. Both of these approaches feed into the estimation of takes as defined under the Marine Mammal Protection Act. He then presented an example of this process from the EIS research for USN LFA Sonar. The example dealt with looking at changes in humpback whale song length after exposure to sonar pings (controlled exposure experiments). The data presented indicated that there is a distinction between immediate and longer-term responses and that the most significant factor in changes observed was time from the last sonar ping, although both immediate and delayed responses were seen. A number of assumptions were used in developing the dose-response risk continuum for this example: that there is a smooth transition in risk from no impact to severe impact (with no thresholds of impact), that there is a 180 dB threshold for risk of serious injury, and that there could be the possibility of unobserved responses that threaten reproduction/survival.

Dr. Fristrup then walked through the application of the acoustic integration model (AIM) used in the example to characterize and predict acoustic environmental impacts. This model combines detailed physical models and simulations of animal movements, and can incorporate additional physical or biological conditions. AIM results were then paired with data from observations. In his example, the modeled results and observation information were consistent, and most individuals' responses were below the critical level in both the modeled and observed results.

He noted that fostering objective assessment should be the goal of such efforts. Development of explicit models that expose their assumptions would help to move the discussion forward. Uncertainty can be addressed by examining the sensitivity of modeled results to variation in the control parameters. These assessments should utilize a peer-review process whenever possible to counter any inherent bias.

Question: Can you compare AIM with ESME?

Response: The two models have the same goals, but ESME is addressing much more detail. The developers of AIM deliberately chose simplifications that reflected the relatively coarse character of the information available about animal distributions and diving behavior.

Question: When looking at risk assessment models, some are more useful on particular elements than on others, but they all seem to have trouble with predicting response. In many cases we do not know what the behavioral response would be or, even if we do know what the response is, what it

means. How do you check the validity of mathematical models if you do not have this type of information?

Response: All of the behaviors observed during and after exposure to the LFA SRP were observed under undisturbed conditions. The range of response behavior was within the range of undisturbed behavior; there were subtle changes in the proportions of each kind of behavior. This manner of response is clearly less serious than the appearance of totally novel behavior patterns, or disruptions in behavior that would be immediately apparent to observers on the scene.

Question: There is an aspect of this that is unsatisfying. The LFA EIS test used sound levels well below the 180 dB threshold on which the model is based, therefore the results of the analysis are pure extrapolation. In the Santa Barbara shipping channel and other areas the ambient sound levels are commonly 120-140 dB and the study's mandate was to figure out the responses to sound above this level, but this was not the question answered.

Response: Our permit limited us to exposures below 155 dB. Also, we were not allowed to emit above 140 dB within three nautical miles of the coast. When we extrapolated risk at higher exposure levels from the lower levels attained in the experiments, we assumed that risk escalated as rapidly as could be justified from prior published work.

Comment: In response to comments regarding how little we know about beaked whales, good points were made, but was this suggesting that we should put no acoustic energy in the water? This is an unrealistic and unnecessary conclusion to make and does not support what was said during the first plenary session about creating a balance, not a polarity, of opinions in order to protect marine mammals.

Response from original commenter: I am not advocating a goal of no acoustic energy input.

Report from Beaked Whale Technical Workshop – Presented by Andy Read, Assistant Professor, Duke University Marine Lab and Member of the Committee of Scientific Advisors to the Marine Mammal Commission

Dr. Read, who was the chair of the Marine Mammal Commission's Beaked Whale Technical Workshop, presented a summary of the workshop, which was held on April 14-16. Dr. Read noted that the workshop attracted numerous participants with expertise in a wide variety of fields. The workshop was successful due to the quality of its participants and their commitment to open discussion of the issues. Three outcomes from this workshop should be highlighted:

- Findings from the workshop supported the idea that the impact of acoustic sources on beaked whales is not primarily auditory trauma, but rather some combination of behavioral responses and non-auditory physical trauma.
- A new potential scenario for a relationship between behavior and non-auditory physical trauma was described.
- Data were presented that showed that current mitigation efforts are ineffective in meeting beaked whale protection requirements because the chances of detecting a beaked whale are very low.

Dr. Read noted a few of the research recommendations developed by workshop:

- The participants were unanimous in recommending controlled exposure experiments on beaked whales to test hypotheses.
- Standardized necropsy protocols must be developed to gather data on physiology, anatomy, and pathology.

- More information on baseline diving behavior and physiology of beaked whales must be gathered.
- A retrospective review of international stranding data is necessary to provide information to fill data gaps and explore new hypotheses.

Comment from Workshop Participant: Beaked whales seem to only click at deep depths and at high frequencies; they do this consistently, but may have silent periods of up to three hours. This means that passive acoustic monitoring is tough to do, but is possible. Old-fashioned hydrophones towed behind a ship are not sensitive enough to pick up these clicks. New technology and innovative approaches are needed. There is some consistency in that beaked whales click for approximately thirty minutes on every dive.

Comment and Discussion: A Committee member noted that he had heard from some workshop participants that there was a discussion of the causes of the beaked whale strandings in the Gulf of California, and that seismic activities could not be definitively implicated as the sole cause of those strandings because the research vessel operating in the area (the Ewing) was using sonar in addition to firing airguns. Several workshop attendees confirmed this Committee member's description of the discussion at the Beaked Whale Workshop. The Committee member further stated that there is only correlational or circumstantial evidence connecting seismic survey activities with beaked whale strandings, and that seismic sources should not be listed as a sound to which beaked whales are known to be particularly sensitive. Some workshop attendees felt that the possibility that the cause of the strandings was airguns was not ruled out; other attendees thought that airguns had been ruled out as a cause of the strandings. Dr. Read noted that it was not clarified definitively in the workshop discussion which sources or sound characteristics were implicated in the strandings involving the Ewing. One researcher had reported that the Ewing was operating its sonar at the time of the stranding. The original commenter noted further that the seismic equipment on the Ewing is not the same as the equipment used in oil and gas exploration activities; another commenter disagreed with this observation. Another workshop participant noted his view that the workshop summary, which leaves open the possibility that seismic testing was a cause in the Ewing incident, is consistent with the sense of the workshop. Lee Langstaff, facilitator for this discussion, noted that the goal of the brief preliminary report from the workshop is to present a general summary for Committee members, and that additional specifics concerning the sound sources will be outlined in the final workshop publication. She further noted that all workshop papers will be published in a peer-reviewed journal.

Comment: Another committee member wondered whether there was a discussion of hearing impacts in the preliminary summary of the workshop. A workshop participant responded that workshop participants had discussed recommendations about hearing studies to be done in conjunction with research on captive and stranded animals, and that these should appear in the workshop summary.

Comment: A question was raised about information presented at the workshop concerning a series of beaked whale strandings in Japan, near a U.S. naval base. Others noted that Jim Mead, Bob Brownell, and others were looking at the strandings in Japan and all strandings records outside of the already well-studied records in the U.S. and U.K. The suggestion was made that this information should appear in the final report of the workshop.

Comment: Another Committee member who attended the workshop noted that it was not the goal to assign blame, but to try to differentiate among effects of various acoustic sources. The workshop

included evidence of fat and gas emboli as a concern, rather than reinforcing the previous focus on temporary or permanent threshold shift. He noted that the most significant outcome of the workshop in his view was the recommendation for an extensive retrospective analysis of stranding data to begin to test the new hypotheses developed at the workshop.

Question: Was there any discussion at the workshop of exposure levels of the stranded animals? Could this information about the levels of sound and whale location be brought to the Committee at a future time?

Response: Yes, this was discussed extensively. Another workshop participant noted that Ken Balcomb's data showed where the animals were habitually located in the Bahamas and that models of the sound fields produced in the Bahamas incident (presented by Gerald D'Spain at the workshop) could suggest an expected exposure of less than 160 dB for approximately thirty seconds of integrated exposure. This kind of information can be used to correlate distribution data with the sound exposure plots to produce a clearer picture of exposures. John Hildebrand and Ken Balcomb agreed to work together to produce a summary of this information for the Committee's next meeting.

Comment: Dr. Read did a good job of summarizing the discussion at the workshop so that the participants and the Committee could have an opportunity to comment on the conclusions reached during the workshop discussion.

Public Comment

Ben White, Animal Welfare Institute. From what I have heard today, we are in retreat from MMPA protection when it means curtailing human activity. The definition of the precautionary principle is: in the absence of information, err on the side of the creature. It seems that we are here because the defense, oil and gas, and research industries see protections for marine mammals as onerous and want to lower them.

Are we talking about acoustic energy? No, we are talking about sound pollution. There are no sounds levels that are beneficial to these creatures. It seems that statements are being made that it is necessary to torture whales and dolphins to get crucial information about their behavior – this is not necessary. Further tests still won't tell us what behavioral changes lead to lethal effects, or alleviate other uncertainties. The committee is making some assumptions that are problematic including:

- The assumption that 180 dB is a safe level for cetaceans. What prompted the change from 120 to 180 dB? This change represents an executive fiat by NMFS, rather than proof that it is safe. There is no information that this change is warranted. We must look at the impacts of lower levels of sound (i.e., Bahamas beachings occurred at levels below 180 dB);
- The assumption that sound propagation is predictable. The models have identified predictable effects from specific sources, but what does this tell us? It seems that these models provide little useful information if additive uncertainty and other factors are impacting their outputs;
- The assumption that there is no trauma if we don't see it;
- The assumption that there is a difference between received levels in air and in water of 60 dB;
- The assumption that there is no appropriate passive substitute to active sonar;
- That NOAA Fisheries' primary obligation is to protect species, not advance industry interests – this has been turned on its head;

- The assumption that the focus should be only on ear impacts; and
- The assumption that sound that results in TTS is a safe level of sound.

These assumptions set the table for disaster. You are lowering thresholds and shifting burden of proof. In current NOAA Fisheries permits for seismic work the level is set at 255 dB. The maximum safe level for the exposure of animals should be 145 dB, the maximum safe level for human exposure. For vertebrate animals we set limits on procedures that cause pain or distress. Whales are dying and that is the real effect of both human seismic and sonar activities in the ocean.

Bob Hoffman, Marine Mammal Commission (retired): I have comments on the informative presentations and discussions that have taken place today.

- 1) Rules of procedure: I have been involved in a number of science committees in which decisions are based on consensus. As the rules are set in this Advisory Committee a single committee member could veto the conclusions made in the report. In short, one person has significant ability to water down the final product. I propose that you include language in your Operating Procedures to the effect that decisions should be made by consensus whenever possible, but when it is not possible then all views should be expressed.
- 2) The 140, 160, and 180 dB criteria levels discussed in the HESS program should not have been averaged – it is better to discuss the pros and cons of all three levels so that people understand the discussion.
- 3) Risk assessment is a tool. Eventually decisions will have to be made about what level of risk is acceptable. Uncertainty, specific interests, and cost-benefit analyses must be taken into account when this level is chosen. What did not arise during the risk assessment discussion was the question of what to do when data are not available to make a decision.
- 4) I have two observations about Dr. Gisiner's comments on databases. The first is that no matter how much primary research is done there is always uncertainty, and predictions are difficult to make. Second, we could use databases to inform prediction, focusing on identifying and detecting effects in existing data rather than projecting or predicting. These databases could be populated through information provided by retrospective analysis on animals and impacts, and other existing data. The Gulf of Mexico and the Beaufort Sea have good data on impacts. Third, in developing databases we must ask what we will do with them. For example, if we detect an effect how do we identify a cause?

Lindy Weilgart, Dalhousie University: We know fairly well where ships and sounds are located, and can model sources and sound transmission fairly well, but determining population effects through modeling is more difficult. We may be able to figure out what one effect has on a population, but in reality there are multiple effects on complicated animals. A key problem is the utter unpredictability of what an animal will do. The ability to add all of the complicated variables together, plus synergistic effects and cumulative impacts is at least ten years in the future. We've had ten years of research since this problem came to the fore, and what can we tell managers now that is fairly widely agreed upon? The problem is so intractable that perhaps it is time for a new approach.

Why haven't we looked exhaustively at all stranding data and correlated it with the available noise data? Why hasn't NOAA Fisheries done this? Models are good for bracketing a problem, but predictions are tough to do in ecological systems. We should shift the discussion to how we could reduce sound production and do source-based technological research. Why not reduce the noise levels and characteristics we think are more dangerous than others?

Further, we are spinning our wheels on the biology. This goes back to Dr. Frstrup's presentation – assumptions are dangerous. Whales are not distributed evenly – they are clumped in groups—but

the model did not capture this. It is also dangerous to assume that we can identify and detect important reactions. We must look at this mathematically, not intuitively. For example, in Dr. Fristrup's presentation the involved scientists did not "feel" there were impacts at tested levels, and the Bahamas beaching occurred at levels below what our models would have predicted. Also, impacted animals may not beach. How much longer will we just study the problem? Reducing our acoustic footprint is key.

DAY TWO –Thursday, April 29, 2004

Suzanne Orenstein opened the meeting by reviewing the agenda for the day, which included a morning session devoted to the science behind the noise exposure criteria that NOAA Fisheries is developing, and an afternoon session devoted to the policy implications of these criteria.

Session III: Emerging Approaches: Noise Exposure Criteria

Background on development and intended use of criteria – Donna Wieting, Deputy Director, Office of Protected Resources, National Marine Fisheries Service. (NOAA Fisheries)

Ms. Wieting introduced the session presenting the work of an expert scientific panel convened by NOAA Fisheries to develop noise exposure criteria for marine mammals. In an environment characterized by increased attention to, and public interest in, the issue of potential impacts of noise on marine mammals, as well as evolving scientific understanding, NOAA Fisheries brought together a panel of science experts to provide the grounds on which to base regulatory and management decisions using the best and most current science available. In addition, NOAA Fisheries hoped that the panel's findings will provide guidance and clarity to the regulated community regarding the impacts on marine mammals from different sound sources, and will create greater awareness and understanding among the interested public.

Ms. Wieting emphasized that the noise exposure criteria to be presented here are a work in progress that will benefit from public discourse and feedback from this well-informed and interested group. NOAA Fisheries is seeking a mechanism by which the best information can be used for each permit application. In presenting the work of the expert panel, the objective is to lay out the current knowledge and the scientific basis for the overall approach to developing noise exposure criteria for use in regulatory decision-making. Today's presentations will focus on the science behind the development of the criteria, including the assumptions, limitations and strengths inherent in the approach. She noted that the expert science panel working on the criteria did so without consideration of potential policy implications of the criteria and therefore should not be expected to discuss policy issues. The implications for policy will be discussed later in the day, when Ms. Wieting will ask for comments and suggestions concerning how the criteria could or should be applied.

History and Scope of Noise Exposure Criteria – Roger Gentry, Acoustics Program, Office of Protected Resources, NOAA Fisheries

In his remarks introducing the work of the noise exposure criteria panel, Dr. Gentry described the expert panel that was convened by NOAA Fisheries and charged to "develop science-based criteria for the onset of tissue injury and behavioral disruption from noise exposure without considering 'harassment' as defined by current law." He explained that the role of NOAA Fisheries has been

to provide resources to the expert panel to work together, but not to control the process or influence its substantive results. In describing the make-up of the panel, he noted that participation is not limited to U.S. scientists but is comprised of individuals considered to be world experts in their fields. The plan is for the results of the expert panel's deliberations to be written up and published in a peer-reviewed journal by 2005.

Dr. Gentry explained that several panel members would be presenting different sections of the panel's work, and highlighted the following points to consider as context for the panelists' presentations:

- The process of developing noise exposure criteria for humans (a well-studied species) has been going on for over 50 years and yet we still lack a single coherent agreed-upon standard. In the case of marine mammals we are faced with the challenging task of establishing criteria for 126 species, most of them poorly studied, and a very broad range of environmental conditions and quite different sound types.
- The lack of data to inform this effort has been the commonly emphasized theme. However, using extrapolations and careful assumptions, the panel has drawn on more extensive data from terrestrial animals as well as available data on a few marine species. The use of extrapolation and assumptions is an accepted approach and is used commonly for issues related to impacts on humans (e.g. experimental use of rodents). Within mammals that lack specializations for processing sound frequency, this is appropriate, as long as the assumptions and extrapolations in the face of uncertainty are made in a conservative manner. The critical issue is to be clear about all assumptions and extrapolations used and, in an environment where scientific knowledge is changing fast, to know where and how to adjust assumptions to incorporate better information. The publication will describe the chain of logic in determining the criteria, facilitating changes in each link of the chain as new information becomes available.
- This first round of work by the panel has focused only on criteria for single individuals exposed to single sound sources, as this is all the limited data allow. Future panels will address other species such as fish and turtles (convening later this year), as well as long term and cumulative effects on populations and habitat as the science becomes available. There is also an ongoing effort to look at the overall noise budget and noise monitoring systems to consider how important human generated noise is in the marine environment on a global scale.
- The panel has more agreement about the work to date on injury and is less resolved on an approach to behavioral impacts. Therefore, not all of the cells of the noise exposure criteria matrix will be presented. However, panelists will lay out the range of options for looking at behavioral disruption in order to illustrate the challenge and complexity of addressing it.
- The reason the panel was explicitly instructed not to consider "harassment" is because there is a desire to keep the panel's work based solely on science and therefore separate from the legal definition of harassment, which could change. There is also interest in these criteria being used by different countries (Canada has already indicated interest), who do not share the same legal framework we have under the Marine Mammal Protection Act.

Dr. Gentry also distributed a paper entitled "Improving Scientific Advice to Government" (F.R. Anderson in *Issues in Science and Technology*, Spring 2003), asking that the Advisory Committee members consider the paper's discussion of how scientific experts can advise policy-makers.

Structure of the Noise Exposure Criteria Matrix – Brandon Southall, Acoustics Program, NOAA Fisheries and University of California, Santa Cruz

Dr. Southall described how the noise exposure criteria are structured in a matrix format by walking through the categories of sound types, marine mammal groups, impact levels, and exposure metrics that make up the matrix. He highlighted the following points:

- Logical groupings of sound types, marine mammal groups and impact levels were identified in order to keep the number of matrix cells manageable. Dr. Southall described these groupings and the rationale behind them:
 - ❖ Sound Types. Four types of sound are categorized based on the characteristics of the noise at the source. These categories are also intended to address how mammal ears react to sounds of different types. While a finer level of detail would be possible, the panel believed that these are the finest gradations that are now possible, given the current state of the research.

Sound Type	Characteristics (at source)	Selected Examples
Single Pulse	Single sound: short duration, fast rise time	Single explosion, pile strike, or airgun, watergun or sparker pulse, single ping of certain sonars/depth finders
Single Non-Pulse	Single sound: long duration, slow rise time	Single vessel pass, drilling event, aircraft overflight, single ping of certain sonars
Multiple Pulse	Multiple sounds: each short duration, fast rise time	Airguns, some sonar/depth sounder systems, waterguns, sparkers, pile driving, serial explosions
Multiple Non-Pulse	Multiple sounds: Each long duration, slow rise time	Multiple vessel/aircraft passes, certain sonar systems, tomography sources

- ❖ Animal Groups. Noting that it would be unworkable to have 126 sets of criteria (one for each species of marine mammal), the panel grouped marine mammals into five functional hearing groups. This also allows for generalizations across groups where sufficient species-specific data are not available (while recognizing that there are species-level and individual-level variations). For example, all of the species in the high-frequency cetaceans category are dealt with generally based on limited data for a few representative species in the group. The groups are:

1. Low-frequency Cetaceans* (e.g. baleen whales)
2. Pinnipeds in air (e.g. elephant seals on land)
3. Pinnipeds in water (e.g. elephant seals underwater)
4. Mid-frequency Cetaceans (e.g. bottlenose dolphins)
5. High-frequency Cetaceans (e.g. harbor porpoises)

The groups were created by taking specific hearing curves (audiograms) and combining them to create group curves, taking the broadest view of hearing frequency ranges in each

group. This is a precautionary approach in developing frequency weighting functions for considering the variable auditory effects of the same kind of sound on animals with very different hearing characteristics. Dr. Bowles describes these “G-weighting” functions in greater detail in her section of this presentation.

*The typical hearing of mysticetes (grouped as low-frequency cetaceans), for whom there are no audiograms, is estimated based on models using data about the sounds they produce and the anatomy of their auditory systems.

- ◄ **Impact Levels.** The noise exposure criteria matrix makes a distinction between noise events causing tissue injury versus those causing behavioral disturbance. In cases where behavioral disturbance may result in injury or death (e.g. beaked whales), the injury criteria are set at the same level as the behavioral disturbance criteria in order to take the most conservative, precautionary approach.
- Dr. Southall also described the exposure metrics used in the criteria, noting the use of dual criteria for sound pressure level (SPL, either Root-Mean-Square or peak pressure) and sound exposure level (SEL, which is the same as energy flux density under certain conditions). The “threshold” value for each of the “cells” in the matrix is considered to be exceeded if either the SPL *or* the SEL is greater than the respective criterion (this is described in more detail below). The dual criteria are used in attempt to capture all the important aspects of the physical variation in the sound waveform. The dual criteria are necessary to cover all possible physical variations in the incoming signal and, because they conservatively complement one another, they are critical aspects of the design of the acoustic exposure criteria matrix.

In closing, Dr. Southall emphasized that while this is indeed one of the most challenging undertakings ever attempted in marine mammalogy, and while it does involve using some simplifying assumptions, it represents a significant advancement in what we have to work with. He noted that the exposure criteria will continue to evolve and be improved upon for the foreseeable future as more and better data become available.

Questions for the panel regarding the structure of the matrix included:

Question: Can the matrix be expanded to include other marine mammals such as sea otters, polar bears, manatees, etc.?

Response: Yes, once information on hearing for those animals is gathered they could be incorporated, however there is currently insufficient data to do so. Many of the admitted limitations of the criteria are indications of the need for more research in areas like this.

Question: Is there a working definition of slow versus fast rise time of sound sources?

Response: The group decided it would be too confusing to talk about characteristics of the sound anywhere it could be detected by a receiver, and so used the sound characteristics at its source. Further, panelists struggled with defining “impulse” and decided to avoid the term because the Acoustical Society of America has been unable to define it.

Question: How do the criteria account for different hearing capabilities at different life stages?

Response: The panel took what it believes to be a conservative approach by using the optimal average hearing of young, naïve (non-exposed) animals. While this may be able to be split out into more categories later when more information is available, the current approach is to lump groups together and make assumptions such as this one.

Question: How many species are in each group and for how many species is there actual hearing data on which to base the criteria?

Response: We are faced with data from only 22 species (of 126), split roughly evenly between pinnipeds and small odontocetes (often from only a small number of individuals). For mysticetes there are no direct data. To develop estimates for those species and groups without data we use an understanding of the relationship between hearing capabilities and anatomy of animals for whom there are data. Thus hearing curves are modeled based on anatomy and the characteristics of the sounds produced by the animals.

Question: Are the estimated audiograms shown in the presentation slides based on Root-Mean-Square data? Did you run into conversion problems between different sound metrics?

Response: Yes, the audiogram graph is based on rms. We will discuss the conversion issues later.

Comment: The panel's product appears to include an overbroad grouping of marine mammals, and to represent the views of a limited group of experts.

Metrics and Weighting Functions (*Charles Greene, President and Principal Scientist, Greenridge Sciences, Inc. and Ann Bowles, Senior Research Biologist, Hubbs-Sea World Research Institute*).

Dr. Greene described the rationale behind using dual criteria for measuring sound exposure. He explained that neither of the common measures for sound pressure level (either peak pressure or the root-mean-square [rms] SPL, adequately account for the duration of a sound. Therefore, Sound Exposure Level (SEL) computation, also referred to as the energy flux density, is used to quantify the cumulative energy over time from a source for its entire duration. In the noise exposure criteria, the threshold is exceeded if either the SPL *or* the SEL is greater than the respective criterion.

Dr. Bowles provided insights into the complexity of determining what sound an animal is exposed to and what kind of effect that exposure is likely to have. She pointed out that sensitivity studies on humans demonstrate that humans do not perceive loudness evenly across all frequencies of sound within their maximal range of hearing. Different species have different thresholds of sensitivity and different perceptions of sound (mediated through hearing, perception/brain processing, and behavior/outcome). Thus in order to understand the effect of a sound, we need to determine which frequencies certain species are capable of detecting well and which frequencies they are not. She described some of the mechanisms by which one can construct different frequency weighting functions as “filters” to account for this phenomenon, in efforts to assess the dosage of exposure received and also to predict the likely effect on the receiving animal. In the case of marine mammals, there are many different species with many different hearing ranges, as well as different sensitivities within those ranges. The acoustic exposure criteria panel constructed frequency weighting functions for each functional hearing group of marine mammals. These weighting functions are conservatively based on human weighting networks and use marine mammal hearing data to estimate the lowest and highest frequencies of hearing for each group. The weighting functions account for the fact that sounds containing energy below and above these frequencies will be much less likely to affect the hearing of species within that hearing group than sound containing energy within the range of best hearing sensitivity. The panel introduced a new weighting function, called G-weighting (for Group), that is similar to C weighting for humans. Sigmoidal dose-response curves have been developed for humans. The goal for the future is to

develop similar dose-response curves for marine mammals based on the results of behavioral studies.

Injury (Permanent Threshold Shift (PTS)) Criteria (*Darlene Ketten, Senior Scientist, Woods Hole Oceanographic Institution and Harvard Medical School and James Finneran, U.S. Navy Marine Mammal Program*)

Dr. Ketten began by explaining that the effort to identify a level of sound that causes physical injury was looked at in the context of the auditory system and the onset of temporary threshold shifts (TTS) and/or permanent threshold shift (PTS). She described the relevant anatomy of mammalian ears and known physical mechanisms for auditory system injury from sound. She made the following key points:

- Efforts to establish guidelines and metrics to protect human hearing (e.g. under the Occupational Health and Safety Act [OSHA]) have involved an interaction between the decibel level and duration of sound.
- TTS is a fact of life and should not be considered abnormal per se. It happens all the time to humans and animals under natural conditions.
- In humans and terrestrial animals, genetic variability as well as age and health are factors influencing how individuals will react to a given sound exposure.
- A key challenge with marine mammals is the low numbers of subjects that have been studied (few individuals of few species). There are large differences in noise susceptibility between individual subjects and between species. Ideally we would have reference points for each species, but we don't. Therefore we need to use surrogate species (e.g. cats or chinchillas) and extrapolate from them. It is critical to determine where and when extrapolation is reasonable, and which surrogates are appropriate.
- What we do know about noise-induced hearing loss is that:
 - Damage to the ear is roughly proportional to total energy exposure
 - Interrupted exposure poses less risk than continuous exposure
 - Impulse sound is more hazardous than non-impulse sound
 - High frequencies are more hazardous than low frequencies
 - Narrow-band sounds produce the maximum hearing loss at the central frequency of the sound
 - Pure tones produce maximum hearing losses at one half octave above the frequency of exposure
 - Broadband sound produces maximum hearing losses at mid-range frequencies.

Dr. Ketten further discussed TTS and PTS, making the following points:

- The Organ of Corti is the fundamental site of injury in PTS
- At the early stages of PTS, damage is to the stereocilia; this damage gradually progresses to hair cells and nerves with increased intensity and time
- There are no consistent structural correlates to help predict moderate or low TTS.

Dr. Finneran focused on how the panel dealt with the need to come up with numerical estimates for the onset of PTS. He made the following points:

- Because it is impossible to conduct direct experiments to determine the onset of PTS in all species of marine mammals for all types of sound exposures, the use of extrapolation becomes

unavoidable. Extrapolations can be based on the small amount of TTS data that are available for a few species of marine mammals (3 species of mid-frequency cetaceans and 3 species of pinnipeds), and also from data on terrestrial mammals regarding the relationship between TTS and PTS (how much TTS happens before the onset of PTS, and how TTS increases with increased exposure level). Dr. Finneran reviewed the techniques used to measure TTS in marine mammals (behavioral response or electrophysiological methods).

- Dr. Finneran briefly described the techniques used to extrapolate from limited data on TTS in mid-frequency cetaceans and pinnipeds in water, to estimate threshold criteria (sound levels above which TTS or PTS is estimated to occur).
- For non-pulse sound sources: terrestrial mammal data indicate that it takes a TTS of greater than 40dB before onset of PTS, and that TTS increases with sound exposure at a rate of about 1.6 dB of TTS for each 1 dB increase in Sound Exposure Level (energy flux density level). This leads to an estimated PTS threshold level of 20 dB (SEL) above the TTS threshold.
- For pulsed sound the relationship between TTS and PTS is less clear. Terrestrial mammal data support the general conclusion that a TTS of greater than 40dB is required before the onset of PTS. However, growth of TTS with increased SEL is uncertain, and the slope may be steeper for pulses than non-pulses. Therefore, an SEL(energy based) criteria has not yet been established by the panel. Instead, a peak pressure limit has been set at 6dB above the TTS onset value as a precautionary approach. As a conservative measure, this applies to both pulses and non-pulses to protect against pulse-like components of non-pulse exposures.

Dr. Finneran walked through four examples to illustrate how this approach would apply: They included

- 1) mid-frequency cetaceans exposed to single non-pulse sound,
- 2) mid-frequency cetaceans exposed to multiple non-pulse sound,
- 3) mid-frequency cetaceans exposed to single pulse sound, and
- 4) pinnipeds under water exposed to a single pulse sound source.

Questions and comments from Committee members regarding injury criteria included:

Question: Dr. Ketten indicated that the criteria are based on the most susceptible, young, un-exposed individuals. However, most of the available data come from captive, older animals in relatively “noisy” environments (where they might have significant hearing loss). It seems that these data are most likely not representative of the most susceptible animals. Was there any attempt to adjust for this?

Response: The reference curves used were for typical “naïve” animals with normal ears. The hearing of the captive test animals was compared against this reference curve. Data from one animal in Santa Cruz who is known to have high frequency hearing loss were excluded. There was no reason to believe that the hearing of any of the other test animals was compromised.

Question: In controlled experiments using pulsed sound sources, how confident are we regarding received levels? Isn't there a reverberation issue in enclosed areas where these animals are tested?

Response: Calibration was conducted before the animal was present in an attempt to deal with this problem.

Question: When and how will the energy-based (SEL) criteria be developed for pulsed sound sources?

Response: They will probably not be released to the public before the peer-reviewed publication comes out. For pending permit applications the old approach will be used. These criteria will be implemented at a later time.

Question: Is there any evidence for applicability of relationship between body size/mass to vulnerability to TTS as has been shown in terrestrial mammals?

Response: There is some anatomical evidence to support that a consistent mechanism might be true for marine mammals but the documentation for marine mammals is not clear at this time. In terrestrial mammals, the bigger the animal the less sensitive it is to TTS.

Question: Was there any consideration of non-auditory physical injury in the criteria?

Response: The focus was on noise-induced hearing loss based on the current evidence that levels of auditory injury occur at levels lower than non-auditory injury. However, the emerging evidence that there may be other mechanisms for injury (e.g. for beaked whales) resulted in the proposal that where data suggest that behavioral disturbance may lead to physical injury or death, the level that triggers the behavioral response will be used as the criterion level for injury. Two key assumptions guided the panel here: 1) that the ear is the most sensitive organ to sound exposure, 2) that the behavior-triggering level is lower than the auditory trauma level and is therefore a minimum threshold. The panel recognizes the need to remain open to the possibility that there may be lower levels of sound that cause injury through some other mechanism (jaw fats were suggested as a possibility), but that until we have evidence for such mechanisms, we must assume mechanisms for which we have the most evidence.

Question: Work done by Art Popper on fish indicates that TTS can last quite awhile and damage may not show up until after 24hours. Was there any effort to look for TTS effects over more than 24hours?

Response: Yes, animals were checked on subsequent days post-exposure to ensure that they returned to their baselines.

Comment: If we are willing to use extrapolations in developing these criteria we should be willing to consider the estimates of exposure levels in the Bahamas that are developed using extrapolation, with the understanding that the assumptions are made clear and transparent.

Response: The Committee should hear from Hildebrand and Balcomb regarding their estimates for exposure levels in the Bahamas strandings.

Question: It seems as if the allowable levels that result from the approach used in developing these criteria are generally going up. Is this true?

Response: It is not accurate to make a blanket interpretation that allowable levels will go up. The approaches are not directly comparable. It is critical to consider the fact that we are using dual criteria and accounting for duration as well as decibel level.

Behavioral Criteria (John Richardson, LGL Ltd. and Peter Tyack, Senior Scientist, Woods Hole Oceanographic Institution)

Dr. Richardson explained that the challenge with regard to establishing behavioral criteria is chiefly in identifying what types and levels of behavioral changes are sufficient to be considered biologically significant. He noted that there is an NRC panel that is explicitly considering the issue of the biological significance in the context of noise exposure. He made the following key points:

- For the purposes of the noise exposure criteria panel, behavioral disturbance is defined as: “behavioral changes that may have a biologically significant effect, i.e., effects on reproduction, and/or survival at the individual or population level.” The group further stipulated that “brief and infrequent responses, startle or otherwise, that are unlikely to affect growth, reproduction or survival of individuals (and thus of the population) are not considered significant” in their deliberations.
- The group recommends a “24 hour/one time only” rule when considering whether behavioral disturbance is significant. That is, if a behavioral disruption resulting from noise exposure lasts less than 24 hours and, for a given individual, occurs only once in an extended period, the disturbance would not be considered biologically significant unless there is specific evidence to the contrary. There is as yet no conclusion about the appropriate length of the “extended period.” This exclusion rule would apply regardless of the duration of the exposure or source operation period; it is the duration of the response (more or less than 24 hours) that is relevant.
- The variability in behavioral responses leads to real problems in trying to set a threshold level of sound exposure. The sources of variability include:
 - Individual changes in responsiveness over time depending on season, context, previous exposure (habituation or sensitization), etc.;
 - Differences between age and sex classes, and inherent variability in responsiveness of individuals;
 - Species variability within the same functional hearing group;
 - Varying responses to different sounds from the same category of sound types.
- The panel is still considering two alternate approaches for dealing with behavioral variability: a single criterion approach and a dose-response function. He described each and discussed their relative advantages and disadvantages.

Single criterion approach. This approach proposes a single number, recommended to be set at a level at which some as-yet-unspecified percentage (but less than 50%) of the animals would show significant disturbance. The criterion level would be higher than the minimum level at which disruption might occasionally occur but less than the level at which 50% of the animals would react. Other criterion levels were also discussed, including 1) the level at which 50% of exposed animals would be expected to respond (average or median level), and 2) de minimus pressure level or SEL above which there may be a take depending upon context. For species and situations where specific behavioral data exist indicating response levels other than “typical” levels for that mammal type and sound type, that information should be used in lieu of the general guidelines (e.g., beaked whales, beluga and bowhead whales in the Arctic).

It is proposed that the single criterion approach be applied in the case of exposures to single “pulse” exposures. The panel has made no final decision on whether this approach will apply for any other types of exposures. Exposures to single pulses rarely cause a biologically significant behavioral response. However, to be precautionary, the sound level causing the onset of TTS is taken as the level above which significant behavioral disturbance might occur. Dr. Richardson provided a few examples of the “behavioral disturbance” criteria on an SPL and SEL basis, for single pulse exposures based on this approach. These are the same as the levels associated with TTS onset.

Dose-response function. The dose-response function approach is appealing because it acknowledges that, for most sound exposures, there is no single pressure or sound exposure level above which significant behavioral disruption always occurs and below which it never occurs. Rather, the proportion of animals showing significant response depends on many factors but generally tends to be higher with higher sound exposure. The dose-response approach accounts for the quantitative relationship between sound exposure and the probability that an animal will exhibit significant disturbance. This approach is more representative of the graduated way in which animals react to noise than is the single criterion approach and it is similar to that used for human reactions to sound (e.g. annoyance). A critical challenge lies in the fact that there are very few cases for which the slope of a dose-response curve (i.e., the quantitative relationship between sound exposure and probability of behavioral disruption) has been sufficiently documented. Establishing a realistic slope has a large effect on the numbers of animals predicted to respond significantly.

- Finally, Dr. Richardson emphasized the importance of exposure duration (as well as sound level) in assessing the probability of a significant behavioral response. The panel is working under the assumption that significant disturbance will be more likely when marine mammals are exposed to a given sound level for a longer time, or for a higher proportion of time. However, they have not reached a conclusion regarding how best to quantify the interrelated factors of sound duration and sound level for the purposes of predicting behavioral response.

Dr. Tyack went on to describe how the panel has been considering the ways in which behavioral responses can be related to adverse impacts, highlighting the many complicating factors that make developing appropriate criteria for behavioral disturbance especially challenging. He made the following key points:

- The biologically significant activities that, if disturbed, could be related to adverse impacts include:
 - growth (feeding and energetics);
 - survival (behavioral reactions leading to injury or death, such as stranding);
 - reproduction (mating behavior); and
 - avoidance and habitat quality.
- Using avoidance behavior (e.g. gray whales abandoning a breeding lagoon during salt mining activities) as an example, Dr. Tyack noted that the significance of behavioral responses must be evaluated on a case-by-case basis, looking at questions such as how critical the affected habitat is, and how much critical habitat is affected. While there is agreement that the panel wants to establish criteria designed to prevent abandonment of critical habitat, this is very difficult to do because long-term studies seldom measure dosage, and have weak predictive power. Shorter-term studies are needed to look at relationships between acoustic exposure and behavioral response. The studies should be designed so that the experiments themselves do not have adverse impacts. The results from such studies must then be extrapolated to novel conditions based on temporal and spatial aspects.
- Dr. Tyack emphasized the need to acknowledge the fact that dose-response functions are context-dependent, using an example of gray whales in inshore and offshore situations. Several questions arise in attempting to incorporate this variability into the noise exposure criteria, and the panel members have not yet been able to agree on the following aspects:

- Should results from different studies be pooled to create a dose-response function for each cell in the matrix?
 - Should the dose-response function include all contexts?
 - Which data should be included (e.g., data from captive animals)?
- Another important factor to consider in determining the significance of behavioral responses to sound is habituation. Where habituation has been studied (specifically with harbor porpoises and pingers), there is evidence to suggest that the area of avoidance may decrease significantly over time. This makes it especially important to understand the zone of avoidance in cases where an animal may be exposed to a sound for more than 24 hours. For example, if avoidance effects last for a long time, it may be appropriate to discount habituation. On the other hand, if the avoidance response lasts less than 24 hours, this habituation must be considered in determining whether the behavioral disturbance is significant (i.e., the 24-hour rule may apply). However, few experiments have studied habituation over time periods greater than one day
 - Issues related to beneficial uses of sound (such as pingers on fishing gear to create avoidance behavior) and the risks of their use particularly need to be looked at on a case by case basis.

In conclusion, Dr. Tyack explained that while the panel has made progress in discussing the principles that should be used in establishing criteria for behavioral disturbance, several aspects continue to be troublesome, particularly with regard to non-pulse sound sources: the data are limited and highly variable; data that are available are not always presented in ways that are directly comparable; and even after existing data are fully taken into account, additional studies are needed to characterize the criteria for some combinations of sound type and mammal type.

Question: The panel's approach seems to consider only direct effects of sound exposure on behavior, but we also need to account for secondary behavioral effects such as increased vulnerability to predators or ship strikes for animals who may have TTS.

Response: These things should be considered but to do so we need to identify baseline and marginal odds of these secondary effects, which are very hard to quantify. The functional consequences to demographics will be very hard to determine, creating the need for more caution. Masking may be the major secondary effect that would come into play. It is not currently accounted for but could potentially be built in.

Question: In setting disturbance criteria, it is evident that there are judgment calls involved with regard to avoidance and habituation and applying appropriate "probability of response" levels (50% or 10%, etc.). This raises the question of uncertainties in the criteria. How are policy makers supposed to deal with this? Statistical tools are used in human epidemiological studies to help with this – is this possible to do here as well?

Response: We can establish uncertainty bounds for cases where we have data and tested hypotheses. These statistical tools are an important part of the process but have not been the focus of the panel's work. The dose-response function approach may be better than a single number criteria approach in reducing the number of judgment calls required.

Question: Why did the panel choose to use a single criteria approach for single pulse sound sources rather than using a step function that acknowledges ignorance and could be adapted to a dose-response curve when more data becomes available for input?

Response: The panel felt that the single criteria approach is easier to conceptualize and that the data exist to support its use for single pulses. For other sound types this approach is problematic and the dose-response function is proposed.

Comment: It would be helpful to see a comparison of the new criteria to the limits on sound exposure that have been historically used by NOAA Fisheries.

In concluding remarks on behalf of the noise exposure criteria panel, Roger Gentry made the following points:

- The noise exposure criteria remain a work in progress, and the draft numbers that have been presented are preliminary and should not be cited.
- The use of extrapolation is essential, and should not be viewed as a bad thing in and of itself, so long as it is validated and revisited periodically as new data become available and the assumptions are clear.
- The group continues to struggle with the challenges associated with the approach for behavioral disturbance. A sub-group of the panel is working specifically on this and will draft a proposal for the full panel to consider.
- There are challenges associated with how the criteria will be applied in the real world. For instance, harbor porpoises exhibit a behavioral response to pingers at 100dB (near ambient sound level), yet NOAA Fisheries requires pingers on fishing nets that produce sounds at higher levels. These challenges will have to be addressed.
- The panel's goal is to publish their results in a peer reviewed journal, with a first draft ready by the end of 2004.

General Plenary Discussion re: Noise Exposure Criteria

Many Committee members expressed their appreciation to the noise exposure criteria panel for their work and their efforts to be clear in their presentations regarding the assumptions and extrapolations used in developing the criteria, emphasizing the value of this transparency. They urged the panel to be sure that this transparency is also reflected in future written products and that it include clear explanations of how decisions are made where there are gaps in the existing data. Committee members raised the following additional questions and comments:

Question: At what point will the work of this panel be incorporated into actual regulatory procedures?

Response: Once published in the peer-reviewed literature, it will represent best available science and can be used in the regulatory process as such.

Question: We appreciate the panel's openness about what extrapolations and assumptions were made. This is obviously a very daunting undertaking. How did the panel work collaboratively?

Response: The panel met four times in long sessions and in a few additional shorter sessions. They worked on a consensus basis, with rapid-fire exchanges of information and discussion. The deliberations are purely scientific.

Question: In panels like this it is vital to reduce the appearance of conflict of interest. Would it be possible to see a list of panelists' affiliations and funding sources?

Response: We do not have such a list at this time. The panelists, who are present today are willing to provide their CVs and sources of funding to anyone. [After the meeting, the Marine

Mammal Commission began gathering this information and to provide it to the Committee members.]

Question: How was the 145dB threshold level derived for humans (in the LFA EIS)? Did it figure into the panel's deliberations, and can the same process be applied for marine mammals?

Response: The 145dB level for humans was derived using navy and recreational divers looking at physiological effects, hearing effects and subjective reactions of "naïve" divers, including their subjective rating of "annoyance" levels.

Question: Can you clarify the relationship between behavioral criteria and injury criteria for cases where behavioral disturbance is suspected to cause physical injury (e.g. beaked whales and a potential non-auditory trauma route of injury)?

Response: In such a case, the level set for physical injury will be set at the same level as the behavioral disturbance level. The panel has not yet decided whether a single number criterion or dose-response approach will be applied.

Question: If the agency were to adopt these criteria, how would this differ from what has been done up until now? How will it relate or compare to the 180dB level for safety zones that has been commonly applied to date?

Response: The critical difference is that the new criteria take in to account duration of the sound source. We believe that overall the new approach is more protective. To illustrate:

Using 180dB as the criteria under the "old" approach:

- 181dB for one second *would not* be allowed
- 179dB for 4 hours *would* be allowed

Using the new criteria:

- 181 for one second *would* be allowed
- 179 for 4 hours *would not* be allowed

Comment: Clearly sound duration is critical. From the standpoint of behavioral impacts, it is difficult to deal with because people generally do not report duration of sound sources, but rather report only the pressure values. It would be helpful to identify reporting guidelines for scientists.

Comment: There may be mechanisms for injury that we have not identified. Harbor and Dall's porpoises in Puget Sound were observed moving away from a moving sound source (mid-frequency Navy sonar) at an estimated level of 140 dB. Necropsies done on 12 dead animals (conducted blind as to which were exposed in this incident) identified hemorrhage that was attributed as possible freeze/thaw autolysis, but no other mechanism of injury was explored.

Responses: Many of the animals examined in the Puget Sound case were in poor condition due to post-mortem change, and thus the cause of death could not be determined (sound exposure could neither be ruled out nor implicated). For some of the other animals in this case, the likely causes of death were identified as injury or illness unrelated to sound exposure. However, some behavioral responses were observed during this incident. This case points out that there may be effects and mechanisms we don't know about and are therefore not currently preparing criteria for. However, the process remains open to data suggesting any mechanism that is not currently being considered.

Comment: It was again suggested by a Committee member that in this Committee's final report the introduction place impacts from sound within the larger context of impacts on marine

mammals from human activities, in particular comparing the impacts of man-made noise to the seemingly more extensive impacts from fisheries bycatch. As a matter of relative scale, what is emerging is the need for a huge amount of resources to do more research to address a problem (sound exposure) that is, in the opinion of the commenter, small compared to fisheries interactions, which are estimated in a recent report to the International Whaling Commission to cause annual animal deaths in the hundreds of thousands.

Response: Bycatch is an important issue for marine mammals, but it is important to remember that the Marine Mammal Protection Act has a separate section devoted exclusively to dealing with the regulation of impacts from fisheries and that the potential impacts of anthropogenic noise on marine mammals is unknown.

Comment: The Commission was asked if they have specific information on threats to marine mammals from other human activities not related to sound, which they confirmed they do. They were asked and agreed to furnish such information to the Committee in advance of the next meeting.

Question: Did the panel look at the relationship between natural and anthropogenic sounds with similar characteristics?

Response: Yes, Jim Miller adapted John Hildebrand's preliminary sound budget (with adjusted numbers for airguns supplied by Jack Caldwell). The panel also developed an ambient noise budget from the perspective of the receiver. In the Northern hemisphere this is dominated by shipping and surface wind noise and in the Southern hemisphere by wind and earthquakes.

Discussion: Several Committee members discussed the importance of understanding complex habituation and sensitization responses. Animals' responses to sound exposures may not remain constant over time. It is important to distinguish between intrinsic aversion responses and trained responses to noise. The threshold of risks must be examined on a case-by-case basis, looking at real-world responses and empirical data.

Development of Policy Guidelines for Application of Noise Exposure Criteria- *led by Donna Wieting, Deputy Director, Office of Protected Resources, NOAA Fisheries*

Ms. Wieting began the discussion by reviewing the process that NOAA Fisheries will use to begin to implement the noise exposure criteria in its regulatory decision making process. The process for finalizing the criteria will include:

- Developing a final draft of the noise exposure criteria
- Publishing a Notice of Intent to complete an Environmental Impact Statement (EIS)
- Publishing the panel's scientific analysis and findings (probably early 2005)
- Decision by Advisory Committee on Acoustic Impacts on Marine Mammals about whether and/or how to address the criteria in its report (early 2005)
- Development of a Draft EIS (possibly within 12-18 months)
- Development of a Proposed Rule (at the same time or shortly after the Draft EIS)

Ms. Wieting asked the Committee members to comment on the process and on the implications of developing and formalizing the noise exposure criteria. Among the comments made during the discussion were the following.

- Many members questioned when the criteria would begin to be used by NOAA Fisheries in its regulatory decision-making. Ms. Wieting responded that they would be applied only after they were finalized, and the Draft EIS was available.
- Several members raised questions about how new scientific information (e.g. data from stranding reports, results of National Research Council's Panel Describing Biologically Significant Marine Mammal Behavior, etc.) would be integrated. Ms. Wieting noted that the criteria could be amended to include new information, and that it is possible that some of that information could be integrated in the coming six-to-nine months, while the Advisory Committee was still meeting.
- Many members commented on the way that uncertainties are addressed in the criteria. Some felt there are several layers of precaution, resulting from conservative assumptions made by the scientists layered on top of conservative actions taken by the regulators. Others noted the significant level of uncertainty in the science (including the extent of extrapolation, the paucity of data on many species, and the fact that it is not known exactly where the critical habitat is for many of the species) and argued for more, rather than less, precaution by the regulators.
- One member noted that the criteria should be further developed before the Notice of Intent to prepare an EIS is published.
- Several members requested that a method be found to outline the science behind the criteria in a way that is more easily understandable to the public.
- One member noted that it was a very positive step to see the Acoustics Panel being very open about the extrapolations, uncertainties and assumptions inherent in the criteria.
- Ms. Wieting asked for feedback about how and whether NOAA Fisheries should address secondary impacts. Some members noted that it is important to include issues like stress levels on the animals. Recognizing that this is hard to do, and given how important it is to address secondary effects, perhaps a fisheries biologist or ecologist could help determine how to address them.
- Another member noted that it is important for the Committee to address how data will be obtained to fill the gaps that arise out of the criteria development process, who will pay for the data collection, and how to overcome permit issues that may make it more difficult to obtain the data.
- Another member noted that, while it seems to some others that the allowable sound levels are moving upward, that is because of the significant investment in research and the resulting improvement in the information available. What is needed is to assign confidence levels to the data that are available. Several additional members echoed the view that understanding the power of the science that is available, and being explicit about the limits of that power, is an important part of developing and implementing the criteria.
- A member suggested that information made available at the recent Beaked Whale Technical Workshop would support the conclusion that nothing greater than the human standard of 145 db be used for marine mammals.
- One member suggested that when making policy decisions, NOAA Fisheries use the following factors in addition to the noise exposure criteria: the status of the stock, the strength of the data about the anatomy of the animal, vulnerability factors, and information about prior injuries from sound for the species involved.
- Regarding the structure of the matrix (i.e. cell structure, groupings of species) there was a suggestion to return to this when the matrix is further developed so that the Committee members could comment more fully. Other members noted that the root mean square (RMS) metric used in the matrix is not a good measurement for short pulses, and that a norm for conversion of the matrix numbers for seismic sound sources may be needed.

- Individual Committee members made the following proposals to NOAA Fisheries regarding the implementation of the criteria:
 - Take care not to assume that TTS and PTS are the only injuries of concern;
 - Integrate information from stranding events, which are not currently being considered;
 - Integrate information from the National Research Council Panel on Describing Biologically Significant Marine Mammal Behavior;
 - Consider the criteria as an adaptive management framework;
 - More clearly emphasize the policy overlay on the scientific findings;
 - More clearly explain the precautionary elements of this approach, and be open about how many layers of precaution may be embedded in the criteria;
 - Include in the formulae by which matrix numbers are derived, a precautionary factor that reflects the uncertainty inherent in the process, as is currently done for Potential Biological Removal under the MMPA;
 - Support research that allows us to obtain more complete data;
 - Develop a practical way to address secondary effects in the absence of data;
 - Use data about stock status when making regulatory decisions;
 - Coordinate with the U.S. Commission on Ocean Policy implementation effort to build support for the science and policy needs that are reflected in the Noise Exposure Criteria development process;
 - Allow the panelists to be available to the Committee as both move forward on the issues. The Committee should discuss at a later date the policy issues, such as using a potential biological removal (PBR) factor or behavioral effects, the strength of a dose/response approach, etc.

The discussion ended with agreement from NOAA Fisheries and the Committee that more discussion on this would be useful. There was a proposal to return to the criteria at the November meeting, and that proposal was accepted.

Update on International Workshop

Erin Vos, project manager for the Sound Program at the Marine Mammal Commission, provided an update to the Committee about the proposed international workshop, scheduled for September 28-30 in London. She reviewed the goals for the workshop and the draft agenda, which will be revised in the coming weeks to take into account input provided in the informal discussion held with Committee volunteers on the previous day. She noted that the Commission has decided to co-sponsor the meeting with the Joint Nature Conservation Committee (JNCC), a U.K. agency involved in the regulation of the effects of anthropogenic sound on marine mammals. JNCC will be meeting with the Commission on May 17 in the afternoon to further refine the workshop plan, and Committee members are welcome to join that discussion if they desire to do so.

PUBLIC COMMENT

Lindy Weilgart, Dalhousie University: Dr. Weilgart made the following comments:

- The panel needs an ecologist or population biologist to address some of the controversial issues. It is important that the panel recognize that they do not represent all of the world's marine mammal scientists.
- The uncertainties inherent in the risk assessment topics are huge, especially concerning the understanding of whale populations. Our abilities to detect effects and relate them to a sound source are severely constrained, as scientists who conduct field research can attest to.

- Regulations may be too blunt an instrument. For example, our regulations did not anticipate or adequately deal with the effects of sound we have seen for beaked whales. Short term, observable impacts may be very different from population level impacts, and we should not assume that our observations deal with this problem.
- The most sensitive individuals of a population could leave an area due to acoustic disturbance, yet this would masquerade as “habituation” since the least sensitive members remain. Only if individuals are identified and tracked over time would the true distinction become apparent – this scenario has already been shown in disturbance studies.

Michael Jasny, Natural Resources Defense Council: Mr. Jasny made the following comments:

- The NMFS panel should reconsider the assumptions they use in judging the relevance and credibility of existing data. It is arbitrary and capricious to extrapolate from data on terrestrial mammals yet give no weight to data acquired on marine mammals from stranding events, simply because the latter have not been published. Perhaps the best example concerns the Bahamas strandings; the exposure levels have been estimated on the basis of propagation analysis and years of survey data – two types of data that are regularly used in environmental assessment – yet those data are not being used in the regulatory process.
- The NMFS panel needs to take into account the more radical forms of uncertainty described in Dr. Harwood’s presentation. Monte Carlo techniques and other methods mentioned by panelists to address uncertainty do not get at the problems of model error or of complete ignorance (e.g. concerning secondary effects and other issues, for which we have few or not data.)
- In response to Donna Wieting’s request for suggestions on how to incorporate more precaution into the process as it moves toward implementation, one might make the following preliminary recommendations. NOAA should incorporate a precautionary buffer into its criteria, related in part to what we know about a species or stock’s status and biology. It should schedule yearly reviews of the criteria for the purpose of adaptive management. It should include public participation in the criteria development and implementation process, beyond the mere opportunity to submit comments on an Environmental Impact Statement. It should look hard at improving mitigation and enforcement of whatever standards are ultimately adopted.

Ben White, Animal Welfare League: Mr. White made the following comments:

- The noise exposure criteria panel does not engender trust, yet it is forming the basis for future regulation. To increase trust, the panel needs scientists not funded by the Navy or NOAA Fisheries, longer-term studies, and validation of assumptions and results.
- The focus on TTS and PTS is a violation of the MMPA, and looks like regulators are trying to determine how much we can shave down the protective standards. Non-acoustic physical effects must be considered.
- Can’t we make quieter ships, develop passive acoustics tools and thumpers along the ocean floor instead of directing sound through a column of water, and explore and use other alternative technologies that will be less damaging to the marine mammals?

Bob Hofman, Marine Mammal Commission (retired): Dr. Hofman addressed the paper by Frederick Anderson (distributed by Roger Gentry) describing processes for improving scientific input into the regulatory arena. He noted that if scientists are making value judgments about the science, they are making policy, which is not their correct role. Panels do not create “scientific advice” for government; they create “advice from subsets of scientists” to government. Working by

consensus, as the noise exposure criteria panel is doing, is by definition policy-making because it requires making value judgments. The panel's report should include all of their disagreements and discussions, or it will be policy, not science.

Adel Hashad, Space and Missile Systems Center, U.S. Air Force. Mr. Hashad noted that using a 50% probability of response or injury level was too high. It is the result of limited data, which is a poor basis for setting the criteria. We really want to know what exposure levels would produce 0% effect, 5%, 10%, etc., so that we can give policy-makers a choice about what level of sacrifice is appropriate for a given species. We need to decide how much we are willing to sacrifice species by species.

DAY THREE – Friday, April 30, 2004

The Committee took up several issues of Committee operations and progress during this half-day session. The agenda included a discussion of the letter sent to the Committee by the California Congressional delegation, the finalization of the Committee's Operating Procedures described earlier in this document, a report from the Subcommittee on the Synthesis of Current Knowledge, a discussion about inaugurating a Subcommittee on Management and Mitigation, and plans for the agenda for Meeting Three scheduled for July 27-29 in San Francisco.

Letter from California Congressional Delegation

The Committee reviewed the letter submitted to the Committee by the California Congressional delegation and the response sent by the Marine Mammal Commission. Individual Committee members made the following comments during this discussion:

- Members expressed appreciation for the Congressional interest in the Committee's work and for the suggestions made about issues to be included in the Committee's product.
- A member noted that Congress has given the Committee a large task, and that the Committee needs to work intensively to produce a product useful to Congress and policy makers.
- Some members questioned whether Committee members had requested Congressional input without discussing the request with the Committee. Jessica Maher from Congressman Farr's office noted that the Congressman has had a longstanding interest in these issues, that his staff attended the first meeting of the Committee, and that the letter was the result of his interest and that of other California Representatives.

Report from the Subcommittee on the Synthesis of Current Knowledge

The Subcommittee on the Synthesis of Current Knowledge presented a report of its progress to date, including its vision for a product aimed at an educated lay audience and a sample of a portion of its product that illustrated the level of detail and information that could be included in its report. The Subcommittee also presented a framework for its product, outlining the elements that would be covered. The presentation slides depicting these elements of the report can be viewed at www.mmc.gov/sound. The Subcommittee is working on a format that outlines what is known, not known or uncertain, and disagreed upon for all acoustic impacts, including those covered by previous NRC reports, and additional topics added by the Subcommittee (e.g. non-auditory impacts, population impacts).

Committee members discussed in detail the need to augment the Subcommittee's membership with an expert on ecosystem impacts, and strongly urged the Subcommittee to do so. Among the additional comments from individual Committee members on the report of the work of the Subcommittee were the following.

- The vision is a good one, and the sample product section is about the right level of detail for our intended audience. Suggestions for elements to include are: identification of data gaps, identification of things we can do to further protect marine mammals, significance of each element to policy, time frame for filling data gaps, and ballpark estimate of the magnitude of the budget to answer the outstanding scientific questions.
- The report needs to be succinct, given the number of topics that need to be addressed. Some advocated for two pages per topic, others for 4-5. The goal is a 20-25-page chapter of the final report, so creating a succinct summary will be necessary, though not easy.
- The draft product needs to be reviewed by scientists, in addition to those on the Subcommittee.
- The issues of population and ecosystem effects must be addressed, although the scientific progress on those issues is not advanced to date.
- Some questioned the value of the large effort needed to complete the task of reviewing and synthesizing the scientific knowledge on marine mammals and sound. Other argued strongly that the product was a very necessary basis for recommendations about research and management needs. Others noted the need to make clearer for the public what is known and what is still subject to debate.
- A suggestion was made to add expertise on forensic pathology or physiology to make sure that topic is covered in the draft Subcommittee product.

The Subcommittee agreed to work together to identify an expert to assist them in assessing the current understanding of ecosystem impacts, and to produce a draft report by July 1. The draft Subcommittee report will be distributed to the Committee and discussed in detail at the July meeting.

Discussion of Subcommittee on Management and Mitigation

The Committee began its discussion about how to proceed to address management and mitigation issues with an identification of the desirable attributes for its report to Congress on the topic. The brainstormed list of suggested elements and components is included as Attachment 3. The Committee reviewed a proposed charge for a subcommittee provided by Natural Resources Defense Council. The Committee then decided to establish a Subcommittee on Management and Mitigation, with the following charge or task for the short term.

Initial Charge to Subcommittee on Management and Mitigation: The Subcommittee should begin developing the information base for Advisory Committee discussion and action on management and mitigation issues.

- Committee members, especially those from Minerals Management Service, Navy, NOAA Fisheries, Fish and Wildlife Service, and California Coastal Commission, should briefly summarize existing management and mitigation methods and procedures. Oil and gas industry representatives, researchers, and others can respond to these summaries and add information after initial information from agencies is compiled. The summary should include:

- Management and mitigation procedures used
- Activities that produce sound
- Costs of management and mitigation
- Information on effectiveness of management and mitigation
- Context of management and mitigation (applicable regions, species, etc.)

The Subcommittee should develop a more comprehensive charge and a work plan and report back to the full Committee in July.

The Committee approved the following membership for the Subcommittee:

Jay Barlow, NOAA Fisheries
 Colleen Corrigan, U.S. Fish and Wildlife Service
 David Cottingham, Marine Mammal Commission
 Phil Fontana, Veritas
 Erin Heskett, International Fund for Animal Welfare
 Michael Jasny, Natural Resources Defense Council
 Kathy Metcalf, Chamber of Shipping of America
 Mike Purdy, Lamont-Doherty Earth Observatory
 Jim Ray, Shell Global Solutions, US
 Frank Stone, U.S. Navy
 Bruce Tackett, Exxon Mobil
 Sara Wan, California Coastal Commission
 Lindy Weilgart, Dalhousie University
 Donna Wieting, NOAA Fisheries
 Judy Wilson, Minerals Management Service

Individual Advisory Committee members also made other suggestions to the Subcommittee, as outlined below. These suggestions were not agreed upon by the full Committee.

1. Use the following items from the proposal from Natural Resources Defense Council for the summaries: methods under review should include, but not be limited to, mitigation technologies, operational restrictions, siting constraints, monitoring techniques, and permitting and other regulatory processes.
2. Use brainstormed list of desirable components as guide.
3. Provide information about links between regulations and the management and mitigation methods.
4. Begin developing an assessment of what is known, not known, and the subject of disagreement.
5. Add recreational activities to the list of sources.

Plans for the Third Meeting of the Advisory Committee

The Committee reviewed a proposed list of topics for the agenda for the next meeting of the Advisory Committee, scheduled for July 27-29 in San Francisco, CA. The proposed list is included in Attachment 4. Committee members suggested the following additional items for the July agenda:

- A review of the information to be developed by John Hildebrand and Ken Balcomb about sound exposure levels for the Bahamas stranding incident;

- Discussion of how the Committee might overlap or coordinate with the U.S. Commission on Ocean Policy activities; and
- An update from NOAA Fisheries about the status of the noise exposure criteria and the final Bahamas stranding report.

A member also requested that the Commission provide the Committee with information about the status of marine mammal health, including mortalities from impacts other than sound. The Commission agreed to provide existing written material, but this issue was not proposed for discussion at the July meeting.

The Committee indicated its desire to meet in plenary session with time for extensive discussions at the next meeting. The facilitators agreed to assist the Committee to do so.

Attachments:

1. List of Participants
2. Revised Operating Procedures
3. Brainstormed List of Desirable Components of Report to Congress re: Management and Mitigation
4. Proposed List of Topics for Meeting 3

Attachment 1

List of Participants

Attendance at the Second Plenary Meeting of the
Advisory Committee on Acoustic Impacts on Marine Mammals

Committee Members (24)

Kenneth Balcomb, III	Center for Whale Research, Inc.
David Cottingham	Marine Mammal Commission
Sarah Dolman	Whale and Dolphin Conservation Society
Chip Gill	International Association of Geophysical Contractors
Marsha Green	The Ocean Mammal Institute
Erin Heskett	International Fund for Animal Welfare
John Hildebrand	Scripps Institution of Oceanography
Robert LaBelle	Minerals Management Service
Kathy Metcalf	Chamber of Shipping of America
Paul Nachtigall	Hawaii Institute of Marine Biology
RAdm. Richard Pittenger, USN (Ret.)	Woods Hole Oceanographic Institution
G. Michael Purdy	Lamont-Doherty Earth Observatory
James Ray	Shell Global Solutions (US), Inc.
Joel Reynolds	Natural Resources Defense Council
Naomi Rose	Humane Society of the United States
Charles Schoennagel	Minerals Management Service
V. Frank Stone	Office of the Chief of Naval Operations (N45)
Buck Sutter	National Marine Fisheries Service
Bruce Tackett	ExxonMobil Corporation
RAdm. Steven Tomaszewski	Office of the Chief of Naval Operations (N61)
Peter Tyack	Woods Hole Oceanographic Institution
Sara Wan	California Coastal Commission
RAdm. Richard West, USN (Ret.)	Consortium for Oceanographic Research and Education
James Yoder	National Science Foundation
Nina Young	The Ocean Conservancy

Alternate Committee Members (9)

Dan Allen	ChevronTexaco Corporation
Diane Bowen	U.S. Fish and Wildlife Service
Michael Jasny	Natural Resources Defense Council
Jim Kendall	Minerals Management Service
Darlene Ketten	Woods Hole Oceanographic Institution
RAdm. Tim McGee	Office of the Chief of Naval Operations (N61)
Alexander Shor	National Science Foundation
Lindy Weilgart	Dalhousie University
Donna Wieting	National Marine Fisheries Service

Presenters (14)

Ann Bowles	Hubbs-Sea World Research Institute
------------	------------------------------------

Claire Burt
James Finneran
Kurt Frstrup
Roger Gentry
Bob Gisiner
Charles Greene
John Harwood
James Miller
Andy Read
John Richardson
Penny Ruvelas
Brandon Southall
Doug Wartzok

Defense Science and Technology Laboratories
Space and Naval Warfare Systems Center
Cornell Laboratory of Ornithology
National Marine Fisheries Service
Office of Naval Research
Greenridge Sciences, Inc.
University of St. Andrews
University of Rhode Island
Duke University Marine Laboratory
LGL, Ltd.
National Marine Fisheries Service
National Marine Fisheries Service
Florida International University and
Marine Mammal Commission

Staff (6)

Alyssa Campbell
Tara Cox
Jeannie Drevenak
Michael Gosliner
David Laist
Erin Vos

Marine Mammal Commission
Marine Mammal Commission
Marine Mammal Commission
Marine Mammal Commission
Marine Mammal Commission
Marine Mammal Commission

Facilitators (4)

Lee Langstaff
Linda Manning
Regan Maund
Suzanne Orenstein

Independent Facilitator
SRA, International
SRA, International
Independent Facilitator

Observers (72)

Blair Anderson
Nora Bakkour
Joel Bell
Colleen Benner
Daryl Boness
Jack Caldwell
Colleen Corrigan
Alice Crowe
Angela D'Amico
Marc Dantzker
Cynthia Decker
Tom Fetherston
Leslie Fillmore
Kellie Foster
Adam Frankel

Office of U.S. Representative Sam Farr
The Center for Sea Change
U.S. Navy
U.S. Commission on Ocean Policy
Marine Mammal Commission
Consultant
U.S. Fish and Wildlife Service
American Petroleum Institute
Space and Naval Warfare Systems Center
Cornell Laboratory of Ornithology
Office of the Chief of Naval Operations (N61)
NAVSEA
SRS Technologies
National Marine Fisheries Service
Marine Acoustics, Inc.

Seth Gabriel
 Anita George
 Kristin Grubbs
 Nicholas Gural
 Sarah Hagedorn
 David Hall
 Mardi Hastings
 Poppy Harrover
 Adel Hashad
 Steven Hipfel
 Robert Hofman
 Ken Hollingshead
 Meike Holst
 Tom Huffman
 Graham Jackson
 Marc Kaufman
 Mi Ae Kim
 Karen Kohanowich
 Anurag Kumar
 Bill Lang
 Jennifer Latusek
 Lisa Lierheimer
 Terri McIntyre
 Jessica Maher
 Rodger Melton
 Clark Merriam
 Bob Moran
 Cdr. James O'Clock, USN (Ret.)
 Scott Patton
 Chris Parsons
 Michael Payne
 Linda Petitpas
 Elizabeth Phelps
 Mark Pierson
 Juliana Prevatt
 Ben Raterman
 Nan Reck
 Michael Rawson
 Leslie Ricketts
 Jennifer Salerno
 Kerry Ann Sawyer
 Earl Sims
 Kimberly Skrupky
 Donald Sova
 Mark Stevens
 Maya Tolstoy
 Susan Tomiak
 Amanda Truett

The National Ocean Industries Association
 ExxonMobil

 PEO IWS
 National Marine Fisheries Service
 SRS Technologies
 Office of Naval Research
 EG&G Technical Services
 SMC/AXFV Space and Missile Systems Center
 U.S. Navy
 Marine Mammal Commission, retired
 National Marine Fisheries Service
 LGL, Ltd.
 Stanley Associates
 Defense Science and Technology Laboratories
 Washington Post
 National Marine Fisheries Service
 U.S. Navy
 Geo-Marine, Inc.
 Minerals Management Service
 SAIC
 U.S. Fish and Wildlife Service
 American Society of Mammalogists
 Office of U.S. Representative Sam Farr
 ExxonMobil
 Cousteau Society
 American Petroleum Institute
 NOAA Marine and Aviation Operations
 NUWC DIVNPT
 George Mason University
 National Marine Fisheries Service
 Office of the Chief of Naval Operations (N45)
 Office of the Chief of Naval Operations (N45)
 Minerals Management Service
 NAVSEA
 Naval Surface Warfare Center
 National Marine Fisheries Service
 Lamont-Doherty Earth Observatory
 National Fish and Wildlife Foundation
 Booz Allen Hamilton
 SRS Technologies
 IAGC
 National Marine Fisheries Service
 SRS Technologies
 National Environmental Trust
 Lamont-Doherty Earth Observatory
 Animal Welfare Institute
 University of Maryland

Courtney Vail
Brian Weitz

Ben White
Beth White
Andrew Wigton
Judy Wilson
Robert Winokur
Andrew Wright
David Zinzer

Whale and Dolphin Conservation Society, US
U.S. Senate Subcommittee on Oceans, Fisheries,
& Coast Guard
Animal Welfare Institute
National Marine Fisheries Service
ExxonMobil
Minerals Management Service
Office of the Oceanographer of the Navy (N096T)

Minerals Management Service

Attachment 2

Revised Operating Procedures for Advisory Committee

Advisory Committee on Acoustic Impacts on Marine Mammals

PROPOSED OPERATING PROCEDURES

As revised at April meeting, with changes from version distributed at the meeting highlighted.

For any voluntary collaborative forum to operate smoothly, it is helpful for those involved to agree at the outset on the purpose for the process and on the procedures by which the group will govern its discussions, deliberations, and decision-making. These draft procedures will be reviewed, discussed, revised and adopted by the Advisory Committee at its first meeting.

1. PURPOSE AND GOAL FOR THE ADVISORY COMMITTEE

The Omnibus Appropriations Act of 2003 (Act), Public Law 108-7, directed the Marine Mammal Commission (Commission) to “fund an international conference or series of conferences to share findings, survey acoustic ‘threats’ to marine mammals, and develop means of reducing those threats while maintaining the oceans as a global highway of international commerce.” To assist in meeting this directive, the Commission establishes the Advisory Committee on Acoustic Impacts on Marine Mammal (Committee), under the Federal Advisory Committee Act, to:

- 1) Review and evaluate available information on the impacts of human-generated sound on marine mammals, marine mammal populations, and other components of the marine environment,
- 2) Identify areas of general scientific agreement and areas of uncertainty or disagreement related to such impacts,
- 3) Identify research needs and make recommendations concerning priorities for research in critical areas to resolve uncertainties or disagreements, and
- 4) Recommend management actions and strategies to help avoid and mitigate possible adverse effects of anthropogenic sounds on marine mammals and other components of the marine environment.

The Committee’s charge is to develop recommendations to the Commission for inclusion in a report to Congress from the Commission. The Commission asks the Committee to develop as much consensus on these recommendations as is achievable. On issues where the Committee does not or cannot reach consensus, this will be noted and the Commission may develop, if it so chooses, its own recommendations to Congress on those issues.

2. STRUCTURE OF THE COMMITTEE

Advisory Committee: The Advisory Committee will consist of those members appointed by the Commission. The full Committee will be the decision-making forum for the Committee. The Commission will have two members on the Committee.

Subcommittees: The Committee may establish subcommittees to assist it in developing draft proposals or products for consideration at specific Committee meetings. The membership of subcommittees is subject to the approval of the Committee and may be drawn from individuals who are not Committee members. All subcommittees work at the direction of and report to the Committee. The Committee will develop a scope of work for each subcommittee, outlining the desired membership and expertise, schedule, and product. Subcommittees will operate by the same consensus rule as the Committee.

Technical Resources: The Committee may identify the need for assistance from technical resource experts for the Committee or for Subcommittees. For expertise for the Committee, the Committee will identify experts through discussion and consensus to ensure that all members obtain information that they find useful. For Subcommittees, the Subcommittee will seek to develop the consensus on the experts it requests. If the Committee or Subcommittee cannot reach consensus on one specific expert, technical experts representing differing views may be consulted. The Commission will assist the Committee to obtain the requested technical experts to the extent that it is economically and practically feasible to do so.

3. PARTICIPATION

Interests Represented: Committee membership is limited to those appointed by the Commission. The list of appointed members is included in Attachment A.

Responsibilities of Committee Members: Committee members are responsible for representing the views of other members in their constituency to the maximum extent feasible, and for communicating with others in their interest group. Members are responsible for ensuring that all significant issues and concerns of their organizations and constituents are fully and clearly articulated during Committee meetings. Members are also responsible for ensuring, to the maximum extent feasible, that any eventual recommendations or agreements are acceptable to their constituents and/or the agencies or organizations that they represent.

Alternates: Each member is expected to attend all meetings in their entirety. Each member can also recommend to the Commission an alternate who will, upon Commission approval, attend meetings or portions of meetings when the member is unable to fill his or her seat. The Committee does not intend for this provision to allow for the de facto representation of two members from a constituency in one seat. Alternates who attend meetings with their Committee member can address the Committee in the public comment period. It is the responsibility of the member and the alternate to communicate to ensure that there are no disruptions in the process when an alternate joins the Committee deliberations.

Participation of Those Who Are Not Committee Members: Committee members may request to hear from experts who are in the room but are not on the Committee.

Other Commitments of Members: Members are asked to:

- Share all relevant information that will assist the Committee in achieving its goals;
- Keep their organizations' decision-makers informed of potential decisions and outcomes, in order to expedite approval for the final product to the greatest extent possible;
- Resolve issues being addressed within the Committee structure, not through side bar discussions and agreements that may place other Committee members at a disadvantage;
- Refrain from characterizing the views of other Committee members, or the Committee as a whole, in any interactions with the press; and
- Support the eventual product if they have concurred in it.

Addition of Members: Additional members may join the Committee only with the agreement of the Commission and the Committee, and only if they represent an interest that is not already represented.

4. DECISION-MAKING AND COMMITMENT

Consensus: When concurrence among the members is desired, the Committee will make decisions by consensus. The Committee will use the following definition of consensus: all Committee members can live with a given recommendation or decision. Committee members are responsible for making known any areas of disagreement throughout the process. If the group cannot reach consensus, members will evaluate the consequences of their disagreement and decide together how to address the lack of agreement with due consideration of the need for full, fair and equitable discussion of all perspectives on any issue. The disagreements will be summarized and can become part of the Committee's report if the Committee so chooses.

Role of the Commission: The Commission will participate as full members of the Committee, engaging in the Committee on the issues and exchanging views on the topics discussed. The Commission will provide technical support to the Committee as requested, to the extent feasible. The Commission intends to use any recommendations on which there is consensus in its report to Congress. On issues where the Committee does not or cannot reach consensus, the disagreements will be described in the Committee report. The Commission will include those disagreements in its report to Congress and may develop, if it so chooses, its own recommendations to Congress on those issues.

Decision-Making Process: Decisions will be made by consensus of those present at the meeting except in the case of concurrence on major products, for which consensus and sign-off from all Committee members will be sought. Major products include draft and final Committee reports.

5. SAFEGUARDS

Good Faith: All Committee members agree to act in good faith in all aspects of the Committee's operation. They further agree that specific offers made in open and frank problem-solving conversations will not be used against any other member in future litigation or public relations. Good faith requires that individuals not represent their own personal or organization's views as views of the entire Committee, and that the views and opinions they express in the Committee deliberations are consistent with the views they express in other forums.

Committee Products: The Advisory Committee will develop draft and final reports to the Commission outlining consensus recommendations and areas of disagreement. The Committee may also develop preliminary draft recommendations, chapters of its final report, and other documents that will assist the Committee in reaching consensus on a final report. All agreements on preliminary products will be considered provisional until the Committee has reached consensus or otherwise finalized its final report.

Commission Report: The draft final Report to Congress from the Commission will be sent by electronic mail to the Committee members and the Committee members will have an opportunity to review and comment. The Commission Report will include verbatim the Committee's report.

Press and External Contacts: All meetings of the Committee will be open to the public, and members of the press may attend. Committee members and facilitators may speak to the press and other entities but all agree to refrain from characterizing the views of other Committee members, or the Committee as a whole, in any interactions with the press.

6. MEETING PROCEDURES

Caucusing: Any member may request a caucus with any other member(s) at any time. The person requesting the caucus will specify who is included in the caucus and how much time is being requested. (This technique will be most useful when the Committee is working to make decisions or to finalize recommendations.)

Facilitation: The Committee meetings will be facilitated. The facilitators will work with the Committee to create a forum that is constructive and balanced for all participants. They will be unbiased in their facilitation and not take positions on the issues before the Committee. The facilitators will work to ensure that the meetings stay on topic and that all points of view are heard during discussions. Facilitators will keep confidential information disclosed to them in confidence.

Open to the Public: Meetings of the Committee will be conducted consistent with the Federal Advisory Committee Act (FACA), and will be open to the public and announced in the *Federal Register*. Recommendations made by subcommittees will be brought to the full Committee for consideration, and will be posted on the Commission's website.

Meeting Summaries: The facilitators will develop summaries of each meeting, in consultation with the Commission. The summaries will be distributed to the Committee or appropriate subcommittee for review prior to their posting on the Commission's web site. The Committee will have ten business days to provide comments and corrections, after which the draft summary will be posted on the Commission's web site. Committee members who desire to do so are free to tape record the Committee meetings.

Attachment 3

Brainstormed List of Desirable Components of Report to Congress Re: Management and Mitigation Issues

Committee Member Suggestions for Committee Report to Congress on Management and Mitigation

The Advisory Committee product on Management and Mitigation should include:

1. Adaptive management approach with research plan and dollars to implement it
2. Innovative solutions to management and mitigation
3. Information for decision makers re: management and mitigation strategies that are available
4. Implementation strategies for management and mitigation, e.g. tax credits, practicability
5. Synthesis of existing management and mitigation techniques and some cursory evaluation of them
6. Balance between economic, national security, and quality of life concerns
7. Filter through current regulatory regime and consider best science
8. Include prevention (pre-mitigation) strategies
9. Look at alternatives
10. Examine international aspects of management and mitigation
11. Evaluation of current mitigation and management measures as well as of preventive measures
12. Information to help regulators know when have the least practicable adverse impact
13. Monitoring aspects
14. Relate to the Ocean Commission Report
15. Review current regulatory regime, especially impact of regulation on marine mammal research under the MMPA
16. Look for non-regulatory options, not just command and control, especially for shipping
17. Link mitigation and management to risk and impacts
18. Look at individual contexts for current management and mitigation options
19. Address monitoring, including effectiveness, legality, and international implementation
20. Look at management and mitigation for research activities and context
21. Have a separate section on monitoring, implementation, and enforcement
22. Outline effects we are trying to mitigate or protect from
23. Role of PBR in the definition of harassment
24. Identify mitigation that is meaningful and necessary
25. Use implementation and monitoring to contribute to the knowledge base and science
26. Identify separately mitigation measures used as research
27. Identify new technologies that reduce noise, monitor noise levels, study animals, etc.
28. Indicate what species group management and mitigation methods are addressing
29. Look at relative usefulness of targeted research vs. monitoring research
30. Look at cumulative impacts and management and mitigation
31. Piggy back monitoring on ocean observing systems

Attachment 4

Proposed List of Topics for Meeting 3

Proposed Topics for Meeting 3
July 27-29, 2004
San Francisco, California

1. Review Product from Subcommittee on Existing Knowledge
 - What is agreed upon as “known?”
 - What are the major uncertainties?
 - What are the major disagreements?
2. Committee discussion of how to address uncertainties and disagreements
 - What are the criteria for prioritizing research on acoustic impacts on marine mammals?
 - What are the priorities for research on acoustic impacts on marine mammals?
3. Management and Mitigation Issues (continued from April meeting)
 - How do we manage risks in light of uncertainty? How do we find common ground on what constitutes an acceptable level of risk?
 - What are the mitigation options for various anthropogenic sound sources (the “tools in the toolbox”)?
 - How do we evaluate the effectiveness of mitigation options (cost, scientific validity, precautionary approach, etc.)? What can we agree upon?
4. Identify barriers to scientific and regulatory efforts, and develop recommendations for addressing them
 - Administration and coordination of research funding
 - Funding availability and research prioritization
 - Availability of researchers to conduct research
 - Information sharing
 - Regulatory issues re: U.S. marine mammal research permits
 - Ethical treatment/animal welfare issues
 - International coordination
 - Others?